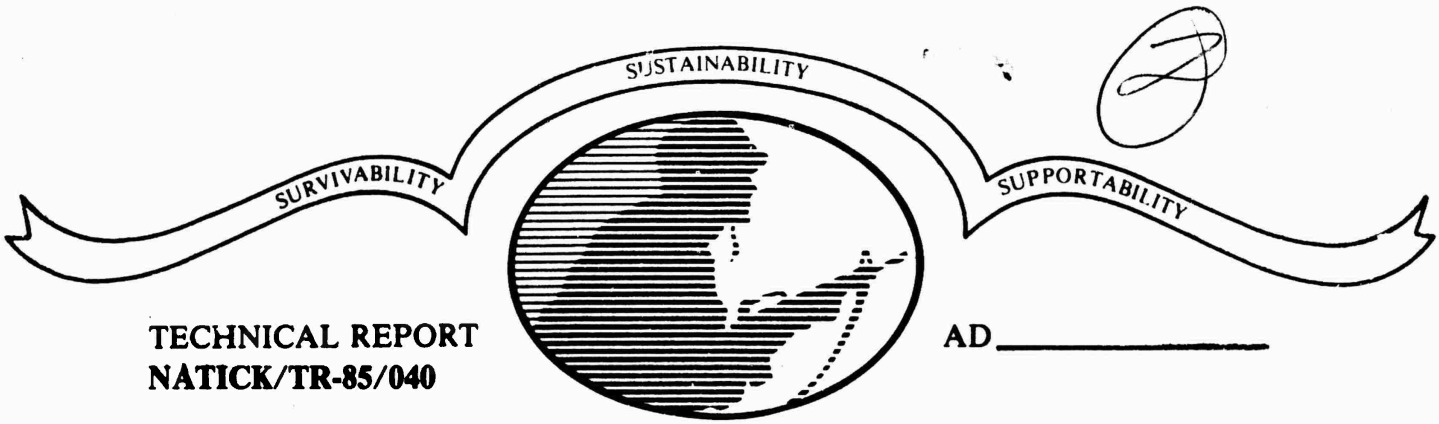

TECHNICAL REPORT
NATICK/TR-85/040

AD_____

FOOD SERVICE SUPPORT FOR GROUND-LAUNCHED CRUISE MISSILE DISPERSED FLIGHTS

BY
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DECEMBER 1984

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DIRECTORATE FOR SYSTEMS ANALYSIS AND CONCEPT
DEVELOPMENT

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1. REPORT NUMBER: NATICK/TR-85/040	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Food Service Support for Ground-Launched Cruise Missile Dispersed Flights	5. TYPE OF REPORT & PERIOD COVERED: Technical Report - Final
6. PERFORMING ORG. REPORT NUMBER: NATICK/TR-85/040	
7. AUTHOR(s): Paul M. Short with Lawrence E. Symington and Santo Gravina	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: US Army Natick Research & Development Center, ATTN: STRNC-OA, Natick, MA 01760-5015	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: PE62724, 1L162724AH99
11. CONTROLLING OFFICE NAME AND ADDRESS: Directorate, Systems Analysis & Concept Dev, US Army Natick Research & Development Center, ATTN: STRNC-OA, Natick, MA 01760-5015	12. REPORT DATE: December 1984
	13. NUMBER OF PAGES: 104
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

MSR AF 82-2

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

TRAY PACKS	FOOD SERVICE PERSONNEL
FLIGHT CREWS	MOBILE FIELD EQUIPMENT
FOOD SERVICE	GLCM
FOOD DISPENSING	GROUND-LAUNCHED CRUISE MISSILE
RATIONS	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

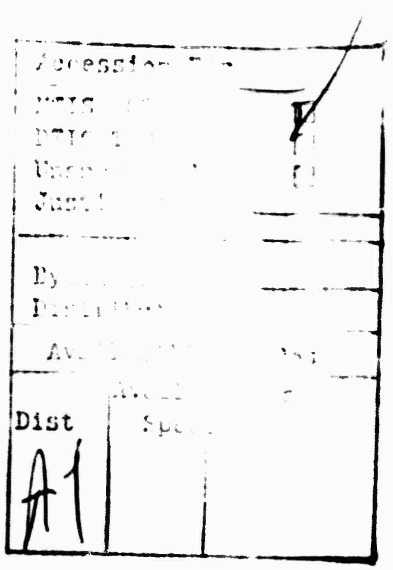
The objective of this project was to provide hot meals to GLCM flight crews in the field without the use of trained food service personnel. Principal system requirements centered around providing one hot meal a day for 50-100 personnel. All signatures such as smoke, noise, and heat had to be minimized to avoid enemy detection. Additionally, the system had to be highly mobile to negotiate off-road terrain, easily set up by two people once on-site, and quickly broken down in an emergency. In the event of a chemical/biological attack, the system had to be easy to decontaminate.

An analysis of state-of-the-art military and commercial food service alternatives led to the selection of Tray Packs as the primary hot food source. This ration concept is particulary attractive since Tray Packs require no refrigeration and offer a variety of fully prepared food items that need only to be heated in their containers and served. The MRE (Meal-Ready-To-Eat) was selected for the remaining two daily meals.

The Air Force selected a standard 5-ton cargo truck to transport the system. Rationale for this decision lay in a need to maintain vehicle continuity within the flight. The highly austere and durable system including the Tray-Pack heater, hot beverage dispenser, and heated serving line was developed and mounted on the truck with appropriate storage space provided for food and disposable serviceware.

A commercial 3-kW diesel-fueled electric generator and Mil Spec diesel-fueled hot water heater were selected to power the food service system.

The prototype unit was constructed and delivered on schedule (1 October 1982) to the GLCM Test Team at Dugway Proving Ground, UT. There, the unit participated in restricted tests during the first quarter of FY83. The unit then travelled in convoy to Fort Lewis, WA where it operated as an integral part of the GLCM flight in a thirty-day "model mission" field test. The field test was an unqualified success -- the unit operated throughout with no mechanical failures or downtime. Randomly selected duty personnel had no problems operating the system and gave it high grades in their critique. Customer acceptance of the system was high. All GLCM-tasked Air Force Commands were favorably impressed with the system.



EXECUTIVE SUMMARY

OBJECTIVE

The primary objective of this project was to develop a system to provide hot meals to European-based, ground-launched cruise missile (GLCM) flights in the field without the use of trained food service personnel.

REQUIREMENTS

Principal system requirements centered around providing one hot meal per day for 50 to 100 individuals in the field without the use of trained food service personnel. All flight vehicles and equipment were to operate on diesel fuel only. All signatures, such as smoke and heat, had to be minimized to avoid enemy detection. Additionally, the system had to be highly mobile, easily set up by two people once on-site, and quickly broken down in an emergency. In the event of a chemical/biological attack, the system also had to be easy to decontaminate.

TECHNICAL APPROACH

A detailed investigation of the planned mission requirements and personnel resources of a fielded GLCM flight was first conducted. Following this, analyses of state-of-the-art military and commercial food and equipment alternatives were conducted. As a result, a concept was developed around the use of Tray Packs (thermally processed, shelf-stable products) as the primary hot food source. The newly developed MRE (Meal, Ready-to-Eat) was selected for the remaining two daily meals. Additionally, as a result of limited space and utilities, it was determined that all major food equipment components, that is, serving lines, counters, storage areas, etc., would have to be fabricated specifically for the system.

In order to maintain vehicle continuity within the flight, a five-ton cargo truck was selected on which to transport the system.

After detailed analysis on the type and suitability of alternative power sources, a commercial 3-kW, diesel-fueled electrical generator and a Military Specification diesel-fueled hot water heater were selected for the food service system.

DESIGN AND CONSTRUCTION

The prototype unit represented a significant challenge due to the severe time constraints and the unique system requirements. Rough design concepts had to be quickly translated into a breadboard prototype. Through intense efforts, a unique, mobile, food service system was developed in-house with a compact, stainless steel Tray-Pack heater, hot beverage dispenser, heated serving line, undercounter storage area, and a self-contained hoist for the generator. The entire system was mounted on pallets for emergency transfer in the field in the event of vehicle failure. Additionally, a modified canvas

cover and bow assembly was designed and fabricated in-house. STANAG Reg. 2154 was referenced to ensure the overall height of the system did not exceed NATO standards for European-based vehicles. A chemical/biological protective overcover was likewise manufactured in-house to provide protection against gross contamination.

TEST AND EVALUATION

The prototype unit was delivered on schedule 1 October 1982 to the GLCM Test Team at Dugway Proving Ground, UT. There, the unit participated in restricted tests during the first quarter of FY83. Field conditions ranged from hot and dry in October to blizzard conditions in December. The unit then travelled in convoy to Ft. Lewis, WA where it operated as an integral part of the GLCM flight in a thirty-day "model mission" test. The field test was an unqualified success -- the unit operated throughout with no mechanical failures or downtime. Randomly selected duty personnel had no problems operating the system and gave it high grades in their critique. Customer acceptance of the system was high. All GLCM-tasked Air Force commands were favorably impressed with the system.

A Specification of Purchase (SOP) is currently being developed at Natick in support of future Air Force procurements.

PREFACE

The principal objective of this project was to design a food service system in support of future ground-launched cruise missile (GLCM) flights. This US Air Force requirement (MSR AF82-2) was assigned to the Directorate, Systems Analysis and Concept Development of the US Army Natick Research and Development Center (NRDC). NRDC project number is PE62724, 1L162724AH99.

The sponsor of this effort was the Food Management Division, Directorate Housing and Services, Air Force Engineering and Services Center, Tyndall Air Force Base, Panama City, FL. The requirement originated under Lt Col Murphy, Director of the Food Management Division and has been completed under the direction of Lt Col Dooley.

This report has been prepared to document user requirements, system analysis of alternative concepts, concept development, prototype construction, and system test and evaluation.

The very nature of such a project directs that a multidisciplinary approach be adopted to successfully address and integrate all the various aspects of the system. The involvement over the last three and one half years of many knowledgeable individuals from the various disciplines makes it difficult to credit each one. As such, the authors wish to express appreciation to all those individuals whose contributions may not have been specifically acknowledged in this text.

The following organizations and individuals have provided support worthy of specific recognition:

Food Management Division, Air Force Engineering and Services Center (AFESC)

Under the foresighted leadership of this command, the planned long-term need of this unique food service system was recognized and supported. This office was particularly helpful in coordinating the requirements and inputs from the various Air Force commands involved in the overall GLCM project.

Joint Cruise Missile Project Office (JCMPO)

Major Madsen's early efforts in scheduling Natick onto the General Dynamics conference agenda and subsequently chairing the food service session were most productive.

Initial Operational Test & Evaluation (IOT&E) Team, Dugway Proving Ground, UT, Air Force Test and Evaluation Command

The IOT&E Team was responsible for field testing the GLCM food service system at Dugway, UT and Ft. Lewis, WA. It was through this team that Natick coordinated the tests and evaluation of the food service system. This command was perhaps the most responsible in influencing the ultimate success and

acceptance of the system. Colonel Bowen (Test Director), Lt Col Skalicky (Deputy Test Director), Lt Col Livingston, Maj Longino, MSgt Pannick, and TSgt Goade, in a most professional manner, took on the added commitments of integrating the food service system into the overall test schedule, supporting the unit, and providing Natick with opportunities to evaluate the system in the field.

US Air Force Joint Technical Staff Representative, NRDC

This project has transitioned from Lt Col Van Dyke, to Capt Berendt, and presently to Maj Rutledge. The collective efforts of these officers have been of great assistance in coordinating requirements between NRDC and various Air Force elements.

Food Engineering Laboratory (FEL), NRDC

As the first project engineer, Mr. John Perry was instrumental in developing early on system equipment alternatives. Taking Mr. Perry's place was Mr. Santo Gravina who has subsequently seen the project through to completion.

Dr. Abner Salant (Laboratory Director) and Mr. Gravina were particularly instrumental in expediting the needed working drawings so that a prototype system could be built at Natick.

Mr. Dominic Bumbaca was primarily responsible for the construction of the prototype unit at Natick. Mr. Bumbaca also attended the field exercises at Dugway Proving Ground and was responsible for a number of successful on-site system modifications.

Miss Virginia White of the Experimental Kitchens developed a fourteen-day menu using only commercially available (shelf-stable) products to determine the feasibility of GLCM ration dependence in this area. Miss White was also instrumental in developing a nutritional profile of the proposed GLCM menu.

Aero-Mechanical Engineering Laboratory (AMEL), NRDC

Dr. Robert Smith (Laboratory Director) and Mr. John Kovar (Chief, Prototype Division) were responsible for the timely construction of the food service unit at Natick. Dr. Smith's priority scheduling of this construction and Mr. Kovar's dedicated and resourceful shop personnel facilitated the successful completion and (on time) delivery of the unit to Dugway Proving Ground.

Mr. Ernest Saab and Mr. Thomas Larkham were responsible for the redesign of the vehicle's bows and canvas assembly, and the chemical/biological protective overcover.

Behavioral s Division, Scientific and Advanced Technology Laboratory ( ), NRDC

Dr. Lawrence Symington was responsible for developing and administering the customer and food service attendant surveys during the "model mission" exercise at Ft. Lewis.

Directorate, Systems Analysis and Concept Development (DSACD), NRDC

Initial guidance and support in developing the system concept for GLCM was provided by Dr. Robert Byrne (former Chief, ORSA) and Mr. Richard Richardson (former Program Manager). Subsequent project assistance was provided by Mr. Mark Davis (Program Manager). Mr. Philip Brandler (Director, DSACD) and Mr. Robert Walsh (Program Manager) have respectively seen the project through to successful completion. Additional noteworthy contributions were made in the areas of logistic support analyses by Mr. George Levesque, menu development by Mrs. Carol Kanter, field test assistance by Mr. George Turk, report production assistance by Ms. Dianna McAllister, and secretarial support by Mrs. Diane Sears and Ms. Katrina Schuh.

DISCLAIMER

U.S. Customary Units are used throughout this text because they were in use at the time by vendors.

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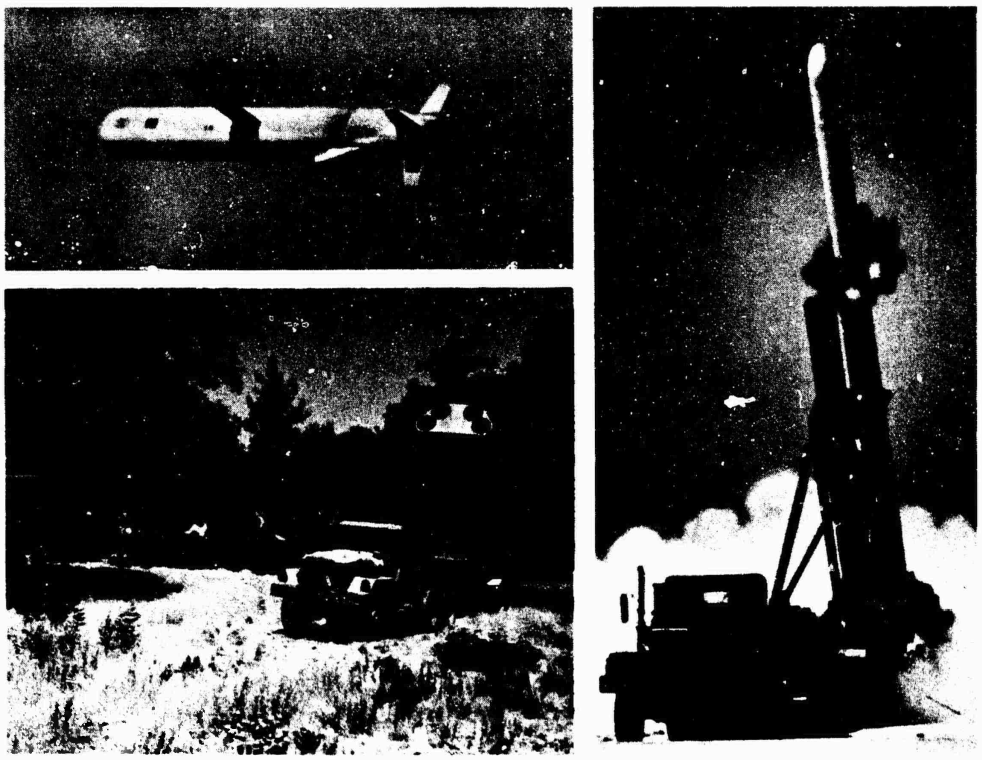

Figure 1. Ground-launched cruise missile.

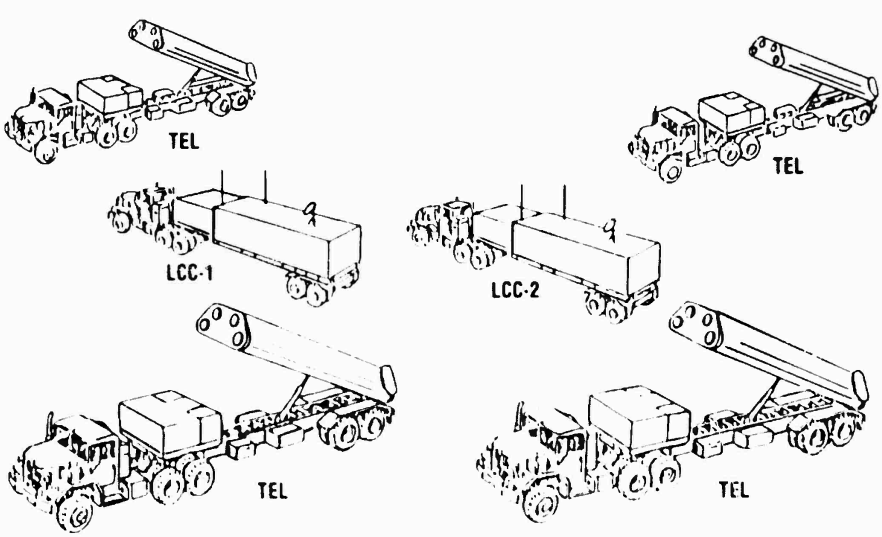

Figure 2. Principal elements of GLCM flight.
TEL - Transporter Erector Launcher
LCC - Launch Control Center

FOOD SERVICE SUPPORT FOR GROUND-LAUNCHED CRUISE MISSILE DISPERSED FLIGHTS

SECTION I

INTRODUCTION

PROJECT REQUIREMENT

The development of the field food service system for Air Force ground-launched cruise missile (GLCM) flights has been a leading priority within the Directorate, Systems Analysis and Concept Development since its inception in October 1979. The initial requirement was pushed ahead two years by the Air Force as part of the overall accelerated effort to deploy ground-launched cruise missiles to the European Theater (Fig. 1 and 2). The system was to be self-contained, highly mobile, feed between 50 and 100 individuals in the field with no food service personnel, and minimize all distinctive signatures.

SYSTEMS APPROACH

Initial inputs were solicited from involved Air Force commands relative to mission requirements and the potential role within the flight for a food service system. From these general inputs Natick developed a series of food service concept alternatives. These concepts were then evaluated to determine a preferred system that would fully support planned mission objectives. The preferred system, with supporting rationale, was presented to all involved Air Force commands in July 1980. From inputs received at this meeting and over the ensuing months, a final design concept was developed by Natick during the 2Q81 and subsequently approved by the Air Force Engineering and Services Center (AFESC) in August 1981.

As detailed in Section II, the concept was to employ Tray Packs as the primary hot food source. This was particularly attractive since Tray Packs require no refrigeration and offer a variety of fully prepared food items that need only to be heated in their containers and served. The food service equipment, all designed for vehicle mounting, consisted of a Tray-Pack heater, hot beverage dispenser, and heated serving line, with appropriate storage space provided for food and disposable serviceware. A commercial 3-kW, diesel-fueled electric generator and Mil Spec diesel-fueled hot water heater were selected in accordance with that specific fuel requirement. A five-ton cargo truck was selected by the Air Force on which to transport the system. This decision was based on a need to maintain vehicle continuity within the flight. Various logistics analyses pertaining to storage and resupply requirements, water and fuel consumption, trash accumulation, repair parts inventories, etc., were provided to the Air Force. In addition, a cost/benefit analysis was provided on various shelter alternatives to support flight personnel. Training guides detailing recommended operational procedures were also developed to assist flight personnel.

During the period January to September 1982 a prototype unit was designed and constructed at Natick and shipped to the GLCM Initial Operational Test and Evaluation (IOT&E) Team at Dugway Proving Ground for preliminary field

testing. There, during the October through December timeframe, the unit participated in a series of "mini-exercises". The system was further tested during a thirty-day "model mission" exercise at Ft. Lewis in January 1983.

RESULTS

Test and evaluation data results were very favorable. The system suffered no downtime as a result of mechanical failures while in the field at Ft. Lewis. As can be seen in Section VII, acceptance for the system by both customers and food service attendants was high.

Involved Air Force commands met at Natick in May 1983 to discuss final system modifications and Initial Operational Capability (IOC) deadlines for upcoming European deployments. In August 1983 AFESC forwarded a Statement of Need (SON) to Natick. This tasking requested that during FY84 Natick make all final modifications to the existing prototype and subsequently develop a well defined "Field Food Service System" Specification of Purchase (SOP) during FY85.

SECTION II

CONCEPT DEVELOPMENT

In July of 1980, a GLCM conference was convened at General Dynamics in San Diego, CA. Representatives from Air Force commands involved with all aspects of system design, testing, and fielding were in attendance. As part of the agenda, an extensive analysis of the various alternative food service options (rations, equipment, and transportation) was presented. Additionally, the best suited of these alternatives were combined and presented by Natick as part of a total food service system concept.

SYSTEM DESIGN CRITERIA

As previously stated, the objective of the project was to provide food service support for between 50 and 100 individuals in the field without the use of trained food service personnel. To determine the suitability of various alternative food service concepts within the overall framework of GLCM mission objectives and resources, the following evaluative criteria were established to aid in system selection:

- Manpower requirement

  Objective - to minimize manhour requirements for system setup and food preparation (hot food to be available no later than one hour after site location), serving, cleanup, and breakdown (the system must be capable of being road ready within 15 minutes of an alert);

- Storage requirements

  Objective - to minimize volume and observe vehicle weight restrictions, determine capabilities to handle dry, chilled, and frozen food items in the field;

- Food acceptance

  Objective - to ensure preference, quality, and variety to maintain prolonged customer acceptance of the system for periods of up to 30 days;

- System safety

  Objective - to perform hazard assessment of alternative methods of food storage, the use of non-food service personnel, various food preparation methods and serving styles, equipment safety, and microbiological safety;

- System mobility

  Objective - to comply with the flight's overall on and off-road mobility requirements;

- Chemical/Biological (CB) resistance

  Objective - to design food preparation and subsistence storage areas to resist gross contamination; overall system design should facilitate easy decontamination;

- System costs

  Objective - to ensure that the system's cost/benefit is acceptable to the end user;

- System availability

  Objective - to determine that all elements of the system are available for immediate and continued purchase;

- Utilities

  Objective - to ensure that the system operates within defined mission parameters, that is, diesel fuel only and minimized signatures;

- System reliability

  Objective - to ensure that all system components demonstrate a high degree of equipment reliability and food consistency.

FOOD SERVICE CONCEPT ALTERNATIVES

Prior to an evaluation of ration alternatives and food preparation techniques, decisions had to be made to define a basic meal concept that would be compatible with the dynamically evolving GLCM mission requirements. For instance, how many meals a day were to be offered and what would be the mix of hot and cold meals? Once decided, what hot/cold meal options would then best accommodate mission requirements? Would food (hot or cold) be provided from within the fielded flight or trucked from the MOB (Main Operating Base)? What type of foods should be used? Was food to be prepared on an individual or group basis? The following illustrates the numerous options that were considered in the analysis:

Daily Meal Structure Options

- 3 cold
- 2 cold, 1 hot
- 1 cold, 2 hot
- 3 hot
- Intermittent hot - every 2-3 days

Cold Meal Options

- MREs (Meal, Ready-To-Eat)
- LRPs (Food Packet, Long Range Patrol)

Hot Meal Opticns

- MREs
- LRPs
- Prepare from recipes
  - A Ration
  - B Ration
- Convenience (Prepared) Foods-Ind./Group Level
  - Frozen
  - Chilled
  - Dehydrated
  - Canned
    - Conventional
    - Tray Packs

1. Daily Meal Structure Options

To facilitate the service of hot food while at the same time maintaining position secrecy/security in the field through limiting movement of people for feeding, the Air Force opted to provide two cold meals and one hot meal. The cold meals were to be eaten by individuals at their post, while the hot meal would be centrally served.

2. Cold Meal Options

In considering cold meal alternatives, few options were available. Under almost any circumstances, cold meals would be considered less than attractive. Given this fact, efforts went into determining the least unattractive of these options. Attention immediately focused on individual operational rations as they were well suited to the individual on-site feeding requirement and, by design, could be eaten cold if required. As such, the Air Force selected the new MRE as they represented a convenient, established source of food with adequate menu variety.

3. Hot Meal Options

Hot meal alternatives were more plentiful, requiring somewhat greater analysis. Out of a concern for morale, it was proposed that a heated individual operational ration would not constitute the daily hot meal. Potential monotony and decreased ration consumption over continuous and extended periods of time prompted examination of alternative sources. Two better known alternatives that were evaluated, A and B Rations, were dismissed on the grounds that both required the talents of trained food service personnel to prepare.

In evaluating the potential use of frozen or chilled convenience foods that could be heated, two major concerns surfaced. First was the logistics effort required to support either system in the field -- the specific storage conditions, mobility, and utility requirements. Second was the concern for personnel with no food service experience dealing with these highly perishable food products. Should the refrigeration unit suffer a mechanical casualty, the entire frozen or chilled food supply could spoil creating a significant logistics problem. If the cooling unit experienced only periodic failures or temperature fluctuations, who would monitor the situation and determine at what point the food could no longer be considered safe for human consumption? A further consideration was the fact that there was a likelihood that all (or most) flight personnel would eat the hot meal. Given this distinct possibility, it was not viewed to be in the best interest of the overall mission to have virtually all flight personnel eating from a commonly affected food source.

Commercial and military sources of dehydrated convenience foods offered a number of alternatives. Long Range Patrol Packets (LRPs), Marine Corps Assault Packets (in development), and a variety of commercially available items in individual serving sizes were considered. The two operational ration alternatives were dismissed in part due to limited menu variety and high cost. The commercially available items suffered under similar analysis. The logistical headaches of trying to assemble a variety of nutritionally balanced meals from a hodgepodge of individual, commercially available items (especially overseas) would have proven impossible.*

The use of shelf-stable canned goods was considered under two separate headings: conventional canned items and Tray Packs. A fourteen-day menu was developed around conventionally available canned items (Appendix A). Two problems became readily apparent. First, can sizes varied dramatically from single serving cans to #10 cans. Planning a menu from such diverse quantities of product presents problems. Secondly, the variety, particularly in the area of entree items, was limited.

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*While only briefly alluded to earlier, the issue of planning subsistence logistics around National Stock Number (NSN) items did enter into the analysis. While, this factor alone did not exclude non-NSN items from consideration, it nonetheless carried significant weight in light of potential purchasing and resupply problems, particularly from overseas bases.

In the evaluation of Tray-Pack items, the positive aspects of the product appeared to far outweigh any disadvantages. The products were commercially available and NSN listed, offered sufficient variety, were fully prepared, shelf-stable, offered reasonable inventory control and portion cost, and of particular importance, were easy to use. While this last factor is difficult to associate with a specific cost benefit, it is nonetheless an important element in the field environment with no trained food service personnel. It is probably best experienced as an absence of problems, rather than measured as a series of positive contributions in such areas as logistics, storage, service, training, and ease of system operations.

Disadvantages in the use of Tray Packs at that time centered around a small production base, little variety in the area of starch and dessert items, and an absence of breakfast items (though not a project requirement). However, in the final analysis, when all the hot food alternatives were considered, it was apparent that the Tray Packs offered the best opportunity to provide simple, adequate, and safe rations in the field. Since that time 77 Tray-Pack items have been developed for military specification in addition to 23 commercial items which are also available, so that the viability of this choice has much improved.

It was concluded then that the daily meal structure would consist of two cold MREs and one hot Tray-Pack meal per day.

SYSTEM MOBILITY ALTERNATIVES

The following transportation alternatives were evaluated by Natick:

- Existing Mobile Field Food Service Systems
- Prototype Mobile Food Service Unit (MFSU)
- Two-Trailer Concept
- 2½-Ton Van* or Cargo Truck**
- 5-Ton Expansible Truck*
- Rigid-Wall Shelters (8' x 8' x 20')

A brief explanation of each alternative follows.

a. The first alternative evaluated focused on the applicability of existing DoD Field Food Service Systems. All were summarily disqualified by the fact that they (1) were designed to facilitate A or B Ration food preparation -- thus requiring trained food service personnel, or (2) were powered by gasoline-fueled M-2 burners, or (3) were significantly oversized for GLCM use.

*hard top vehicle
**soft top vehicle

b. The new Army MFSU prototype offered an interesting alternative as it overcame the previously stated discrepancies, but unfortunately the developmental timetable for fielding the MFSU was one to three years out from the GLCM IOC deadline.

c. The trailer-oriented concept developed by Natick for GLCM required a minimum of two trailers to field the system. One would be designed to carry a 5-kW diesel generator (smallest Military diesel generator available) and the M-80 hot water heater. The second trailer would carry the actual Tray-Pack heating and serving equipment. A third vehicle or trailer would be required to carry the needed quantities of rations to support the flight between resupply missions. This system was not viewed by Natick as a practical alternative, but was nevertheless presented to the Air Force as an alternative for their consideration.

d. The 2½-ton cargo truck and van each offered similar features with the following exceptions -- the van potentially provided more positive CB protection than the cargo truck, but at a cost of approximately $22,000.00 more.

e. The 5-ton expansible truck was an attractive alternative due to the increased working area. Unfortunately, due to limited availability and a high price tag, the expansible vehicle alternative was jointly rejected by Natick and the Air Force.

f. Expandable and standard rigid wall shelters were also rejected from a cost standpoint. While the shelters offered any number of desirable food service, dining, and recreation configurations (see Fig. 3) the initial cost for the vehicle alone (container, trailer, and tractor), even before considering the food service equipment costs, would have been prohibitively expensive.

Natick proposed, based on (1) GLCM system requirements, (2) readily available transportation alternatives, and (3) specific vehicle characteristics and costs, that the 2½-ton van best accommodated GLCM's needs (see Table 1 for evaluation of system transport alternatives). At this time, the end user, US Air Force, Europe, (USAFE) voiced concern on two issues. First, USAFE stated that trailers, food service or otherwise, were an undesirable item in the field, and that all attempts were being made to severely limit their use. Secondly, that vehicle continuity was an important planning element (particularly when it came to logistics support in the field) and that 5-ton cargo trucks were to make up the majority of flight vehicles in the field.

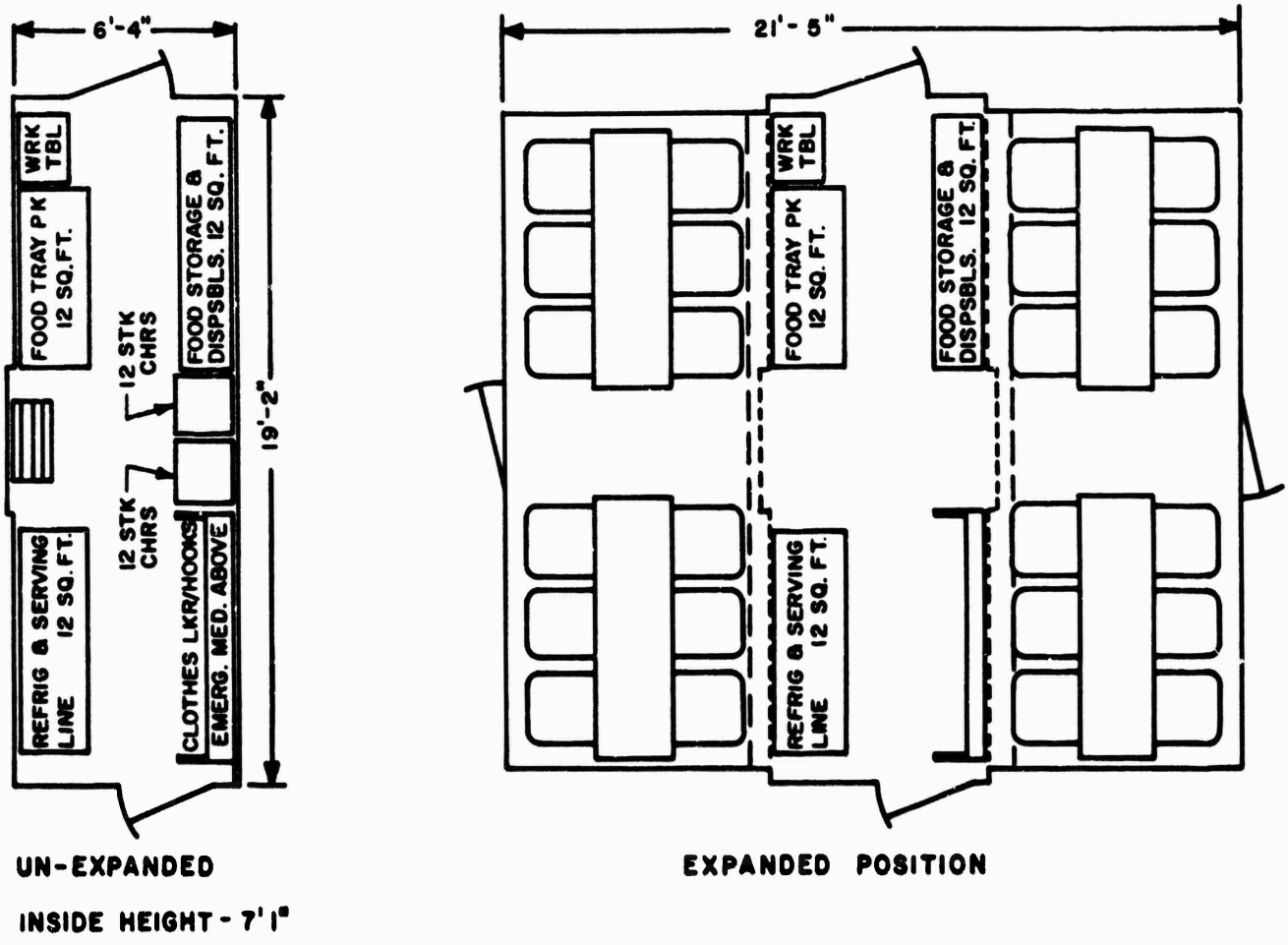


Figure 3. Expandable (3-for-1) rigid wall container -- food service.

TABLE 1. System Transport Alternatives.

ALT. VEHICLE	INTERIOR SPACE FOOD SERV. / HABIT-ABILITY	CB PROTECTION	SET-UP TIME	SPACE HEATER	AWNING SUPPORT	CURRENT AVAILABILITY	VEHICLE COST *
	(FT^2) (FT^2)						
2½ TON CARGO	90 NONE	NO	N/A	NO	NO	GOOD	$ 11K
2½ TON VAN	90 NONE	YES	N/A	NO	YES	GOOD	$ 33K
5 TON EXPANSIBLE	144 90	YES	15 MIN/ 2 MEN	YES	YES	LIMITED	$106K
3:1 SHELTER	120 288	YES	20 MIN/ 4 MEN	NO	YES	LIMITED	$150K

*1980 Cost Figures

Based upon USAFE needs, and taking into consideration various CB protection alternatives, it was concluded that if the end user required the system to be mounted on a 5-ton canvas covered truck, then a CB protective overcover could be produced that would resist gross liquid contamination. It was then agreed that the 5-ton cargo truck (with protective CB cover) would be used as the prime mover for the prototype food service system.

INITIAL CONCEPT DESIGN

The initial concept proposed by Natick at the conference was designed around the following criteria:

- Feed 50 to 100 individuals
- No food service personnel
- Provide one or two hot meals/day
- Diesel fuel only
- Military equipment only
- 2½-ton vehicle
- Limited refrigeration
- Minimized signatures

As observed in the food service layout (Fig. 4), customers would enter the vehicle, serve themselves from the heated serving line, draw off hot or cold water for a beverage, and exit the vehicle via the second stairway. The food service attendant would stand behind the heating/serving line removing Tray Packs from the hot water bath and opening them as needed.

It was invisioned that the water trailer shown in the illustration would be towed by a vehicle in the flight other than the food service vehicle. The second trailer, carrying the 5-kW diesel generator and the 700,000 Btu M-80 water heater would, by design, be towed by the food service vehicle.

The following system support data was additionally provided:

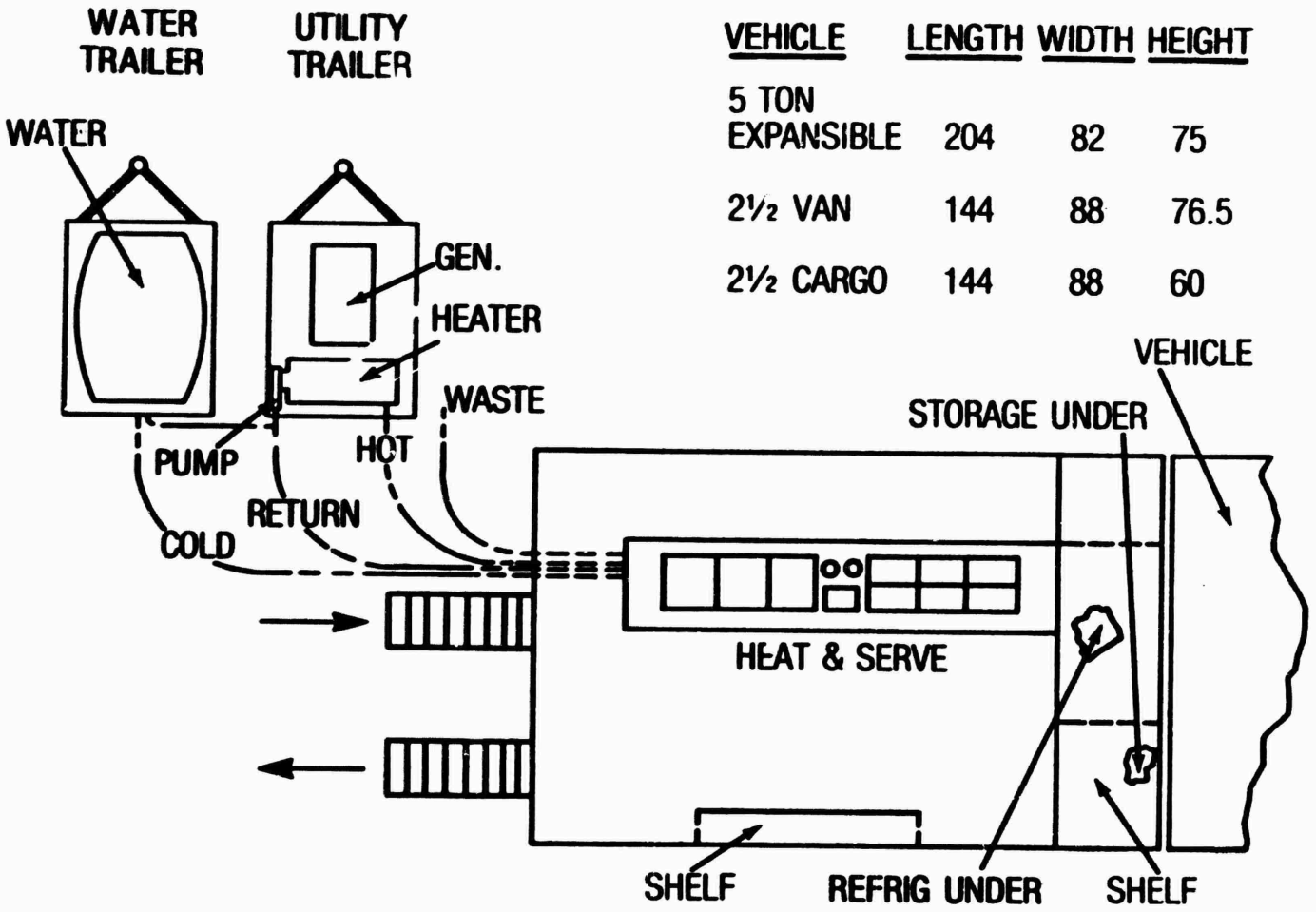
(a) A ration analysis (see Table 2) demonstrated that, from a ration cost and storage perspective, Tray Packs offered a distinct advantage over MREs. Although shown as part of the analysis, weight was not considered a critical factor;

TABLE 2. Ration Analysis.

	Daily Totals			
	MRE[1]	Tray Pack[2]	A[3]	B[4]
Cost/Meal*	$4.60	$1.99	$11.19	$8.58
Storage/75 Men/Meal	5.6 ft^3	4.4 ft^3	15.6 ft^3	14.4 ft^3
Weight/75 Men/Meal	95 lb	170 lb	360 lb	435 lb

*1980 Cost Figures

[1]Meal, Ready-To-Eat
[2]Includes Entree, Starch, Vegetable, Dessert
[3]Two MREs and One Tray-Pack Meal Per Day
[4]One MRE and Two Tray-Pack Meals Per Day



VEHICLE	LENGTH	WIDTH	HEIGHT
5 TON EXPANSIBLE	204	82	75
2½ VAN	144	88	76.5
2½ CARGO	144	88	60

Figure 4. Food service layout.

(b) Disposable serviceware data are presented in Table 3. The concept of a mess kit laundry line with all of its associated problems--increasing the flights overall water requirement, providing diesel-fueled heating equipment, and monitoring mess kit sanitation--left no doubt that the modest volume penalty associated with using disposable serviceware was justified;

TABLE 3. Disposable Serviceware.

Items*	Cost/Flight/Day**	Cube/Flight/Day
Trays	$20.25	0.90
Dining Packets	18.75	.12
Hot Cups	2.40	.38
Total	$41.40	1.40 ft^3

*75 men/day

**1980 Cost Figures

(c) Operational (manning) requirements, as shown in Table 4, were based on 1- or 2-man crews;

TABLE 4. Food Service Operational Requirements.

	Length of Time (minutes)	
	1 Man	2 Men
Startup	30	15
Heating	45	45
Meal Service (Variable)	60	60
Secure	30	15
Total	165	135

(d) The figures shown below represent system hardware cost estimates.

1½ ton trailer	$3,310
5-kW generator	7,406
M-80 water heater	6,200
Storage/Counters	5,500
Heating/serving units	5,000
Miscellaneous	1,100
TOTAL	$28,516*

*Labor and prime mover costs not included.
1980 Cost Figures

HUMAN ACCOMMODATIONS VAN PROPOSALS

In December of 1979, at the request of the Joint Cruise Missile Project Office (JCMPO), Natick agreed to develop alternative proposals for what was being referred to as a human accommodations van. The general thought was to investigate modest systems that could offer some degree of shelter and sanitation facilities to flight personnel in the field. The following alternative systems were proposed.

The first alternative presented was no more elaborate than a standard 5-gallon shower pail that could be filled with water and hung from a tree limb. The second alternative presented was the Army field bath (shower) unit. This was certainly feasible in that the M-80 hot water heater required for this shower unit was the same unit being proposed to heat Tray Packs under the initial (food service) concept design.

Another option was a collapsible 12-man basin unit with mirrors. While this was a prototype model being developed at Natick, it was determined that a unit could be made available for testing if the Air Force was interested. The remaining four options were configured around several vehicle and rigid wall shelters offering various shower, chemical toilet, sleeping, recreation, and lavatory configurations (example, see Fig. 5). These units potentially offered sufficient flexibility to be used as personnel decontamination stations in the event of CB attack.

It was concluded that while these alternatives represented "nice to have" amenities, they did not lend themselves to the end users' "bare bones, lean and mean" concept of operations being proposed for GLCM and, as such, were not adopted.

SUMMARY OF REQUIREMENTS

Prior to actual design and construction of the prototype unit, a summary review of the major system requirements requested by the Air Force were that:

1. Tray Packs would be used for hot meals;
2. MREs would be used for cold meals;
3. the system would be mounted on a 5-ton cargo truck;
4. no food service personnel would be required;
5. only diesel fuel would be used;
6. some level of CB protection would be provided;
7. all signatures would be minimized;
8. the power source would be organic to the system;

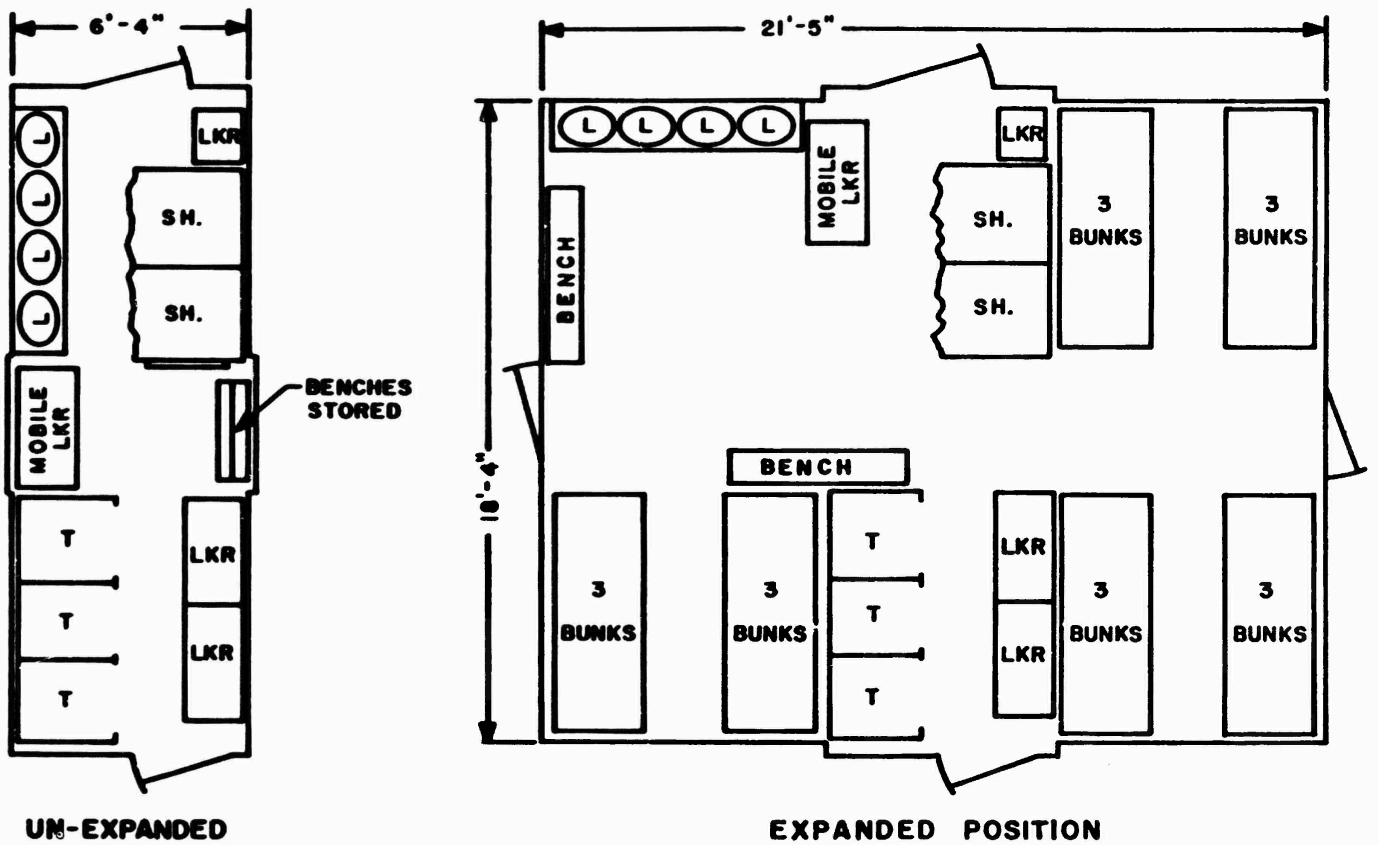


Figure 5. Expandable (3-for-1) rigid wall container -- berthing/sanatation.

9. the food service vehicle would tow a water trailer;

10. the Tray-Pack inventory would be carried in the food service vehicle and MREs would be stored elsewhere;

11. no requirements existed for any human factors facilities.

SECTION III

PROTOTYPE CONSTRUCTION

In December 1981, organizational efforts began with identifying and coordinating the various elements within Natick that would be participating in the planning, design, and construction of the prototype food service system. As project coordinator, the Directorate, Systems Analysis and Concept Development would have overall responsibility for the task. The Food Engineering Laboratory was to provide all necessary working drawings and oversee actual construction of the prototype unit. The Aero-Mechanical Engineering Laboratory would provide the shop facility, manpower, and expertise of their personnel in fabricating and assembling the various elements of the system.

Work started on the drawings in January 1982. Material specifications and quantities were hastily identified for procurement and delivery. In April, the 5-ton cargo truck arrived at Natick and construction on the prototype unit began in earnest.

The following is a brief description of the system components.

PRIME MOVER

Vehicle: A 5-ton cargo vehicle (long bed) was used for the prototype due to the nonavailability of an M-925. The M-925 will, however, be the vehicle used in Europe by GLCM flights once deployed (Fig. 6).

Vehicle Covering: A standard canvas cover for the vehicle was modified as follows: (1) the canvas sides were lengthened to accommodate bow extensions; (2) two 35" x 70" screened window openings with flaps were added for better ventilation; (3) a screened rear panel was fabricated for the entrance; and (4) a stove pipe opening was cut through the top.

Chemical/Biological Protective Cover: The overcover was manufactured from: cloth, laminated, Chloroprene coated, forest green.* The cover was butt-seam constructed with a heavy duty zip-lock closure on the entrance. The cover was designed to slip over the existing canvas cover and be secured from underneath the vehicle.

Pallets: All system equipment was attached to two equal sized steel pallets each measuring 6'6" long and 6'11" wide. These pallets were secured to the bed of the vehicle with four side-locking bolts. The slats of the pallets were 4" wide and spaced 1" apart. The design allows for easy removal of the system by forklift or crane in case of vehicle breakdown.

Stairway: The stairway consisted of seven steel steps with side railings. The stair treads were of the all weather open diamond shape with serrated surfaces. It attached to the back of the vehicle with two hooks and was secured in the vehicle during transit.

*MIL-C-43944, Type I, Class I

Figure 6. Five-ton cargo vehicle (M-925).

The stair treads were 36" wide, 9" deep with a rise of 8". Stair railings were detachable (Fig. 7).

MEAL PREPARATION/SERVING EQUIPMENT

Tray-Pack Heater: The Tray-Pack heater (a stainless steel tank) was designed to heat six baskets simultaneously with each basket holding five Tray Packs. Hot water was used as the heat source to bring the Tray Packs to a temperature of 180°. A three-section hinged lid covers the heater. Each section of the lid can be secured with latches on the sides of the tank to reduce spillage when the truck is moving. A ½-HP pump is mounted under the tank for circulating water from the hot water heater through the tank.

Serving Counter: The serving line consisted of three Cambro insulated containers Model 125 MPC. Each measured 25" x 17" x 5¼" and were inserted into the top of a stainless steel shell. Each container held two Tray Packs and had an insulated top to keep the Tray Packs hot (140°F) during serving periods (Fig. 8).

Beverage Dispenser: A commercially available hot beverage dispensing unit (Jet Spray, Model FC3) was mounted to the top of the Tray-Pack storage cabinet. The unit would be used to dispense hot water only (Fig. 9).

Can Opener/Counter: The can opener used was an Edland Model 1-R. The customary base plate was not required and the opener was mounted directly to the top of the stainless steel cabinet. The bayonet-type blade on the can opener was the best design to open Tray Packs. The opener was constructed of cast iron with hardened and tempered steel knife and gear (Fig. 10).

UTILITIES

Water Heater: The water heater used was a commercial Way-Wolff Ship Heater, Model 917-6C. It was of the fire tube, two-pass design. A combustion chamber comprised the first pass and the return fire tubes the second pass. The boiler was welded steel construction throughout. The oil burner was a fully automatic, high-pressure atomizing type, with a motor directly connected to a blower supplying air for combustion. A fuel unit drew oil from the fuel tank and delivered it under controlled pressure to the atomizing nozzle. The heater delivered a maximum of 80,000 Btu/hr under heavy load conditions and 50,000 Btu/hr under normal conditions. The unit used diesel fuel oil per military standard.* The electrical requirements were: Direct Current 32 or 15 volts, or Alternating Current 110 or 220 volts, 50 or 60 cycles, single phase. Wattage requirements were starting 325, running 150. It had a maximum firing rate of 0.75 gal/hr (Fig. 11).

Generator: The generator used was a commercial type Onan DJA Series (see Fig. 12). It was a 3-kW, diesel-fueled engine with a 30-cubic-inch piston displacement, 19 to 1 compression ratio, and was air cooled. The diesel fuel consumption was 0.21 gal/hr under no load, 0.26 gal/hr under ½ load, and 0.34 gal/hr under full load. There are currently no 3-kW, diesel-fueled generators

*Military Specification MIL-F-16844

Figure 7. Food service vehicle stairway with railings.

Figure 8. Serving counter.

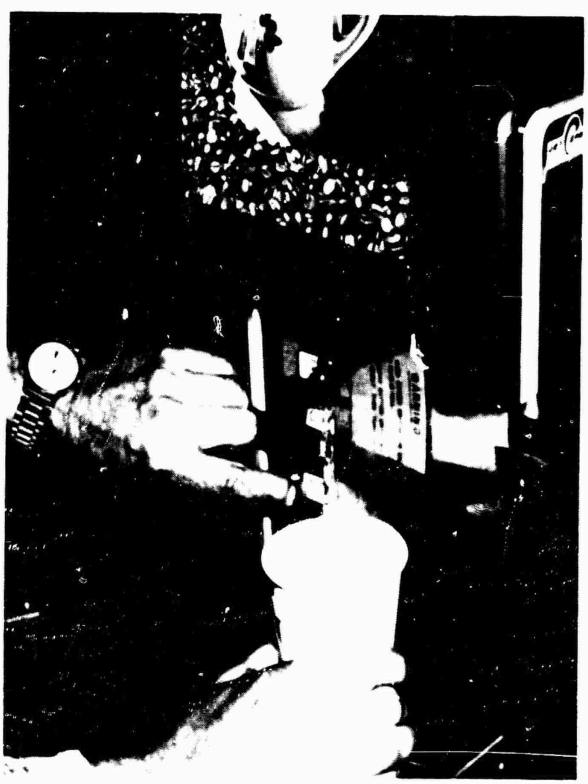


Figure 9. Beverage dispenser.

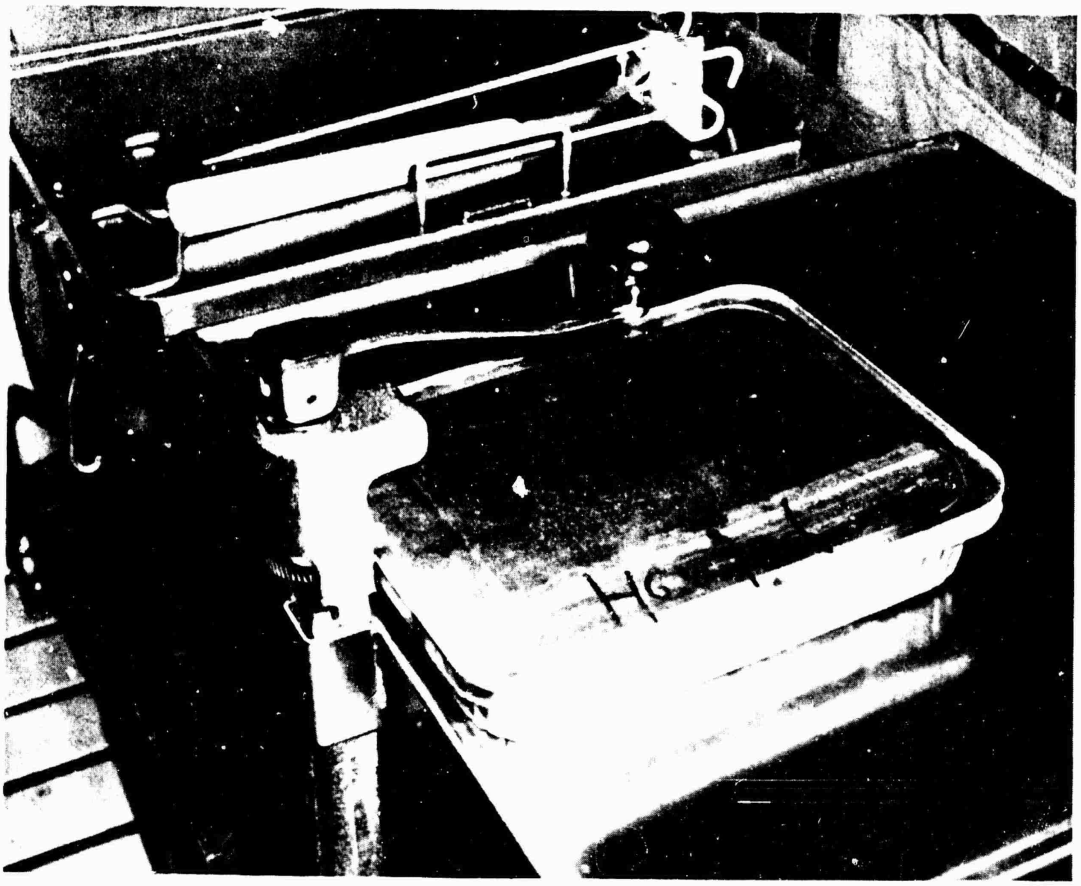


Figure 10. Can opener/counter.

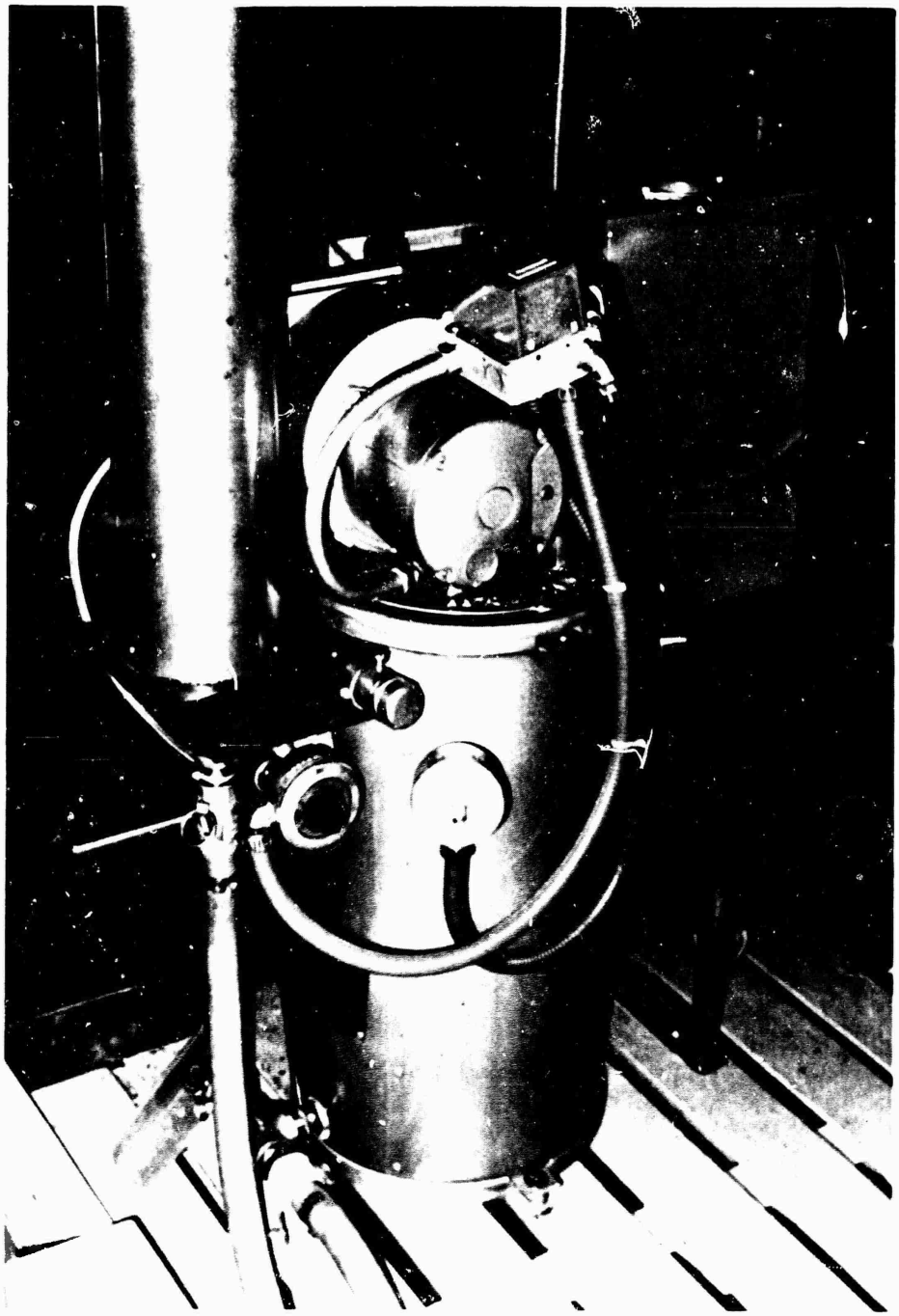


Figure 11. Water heater.

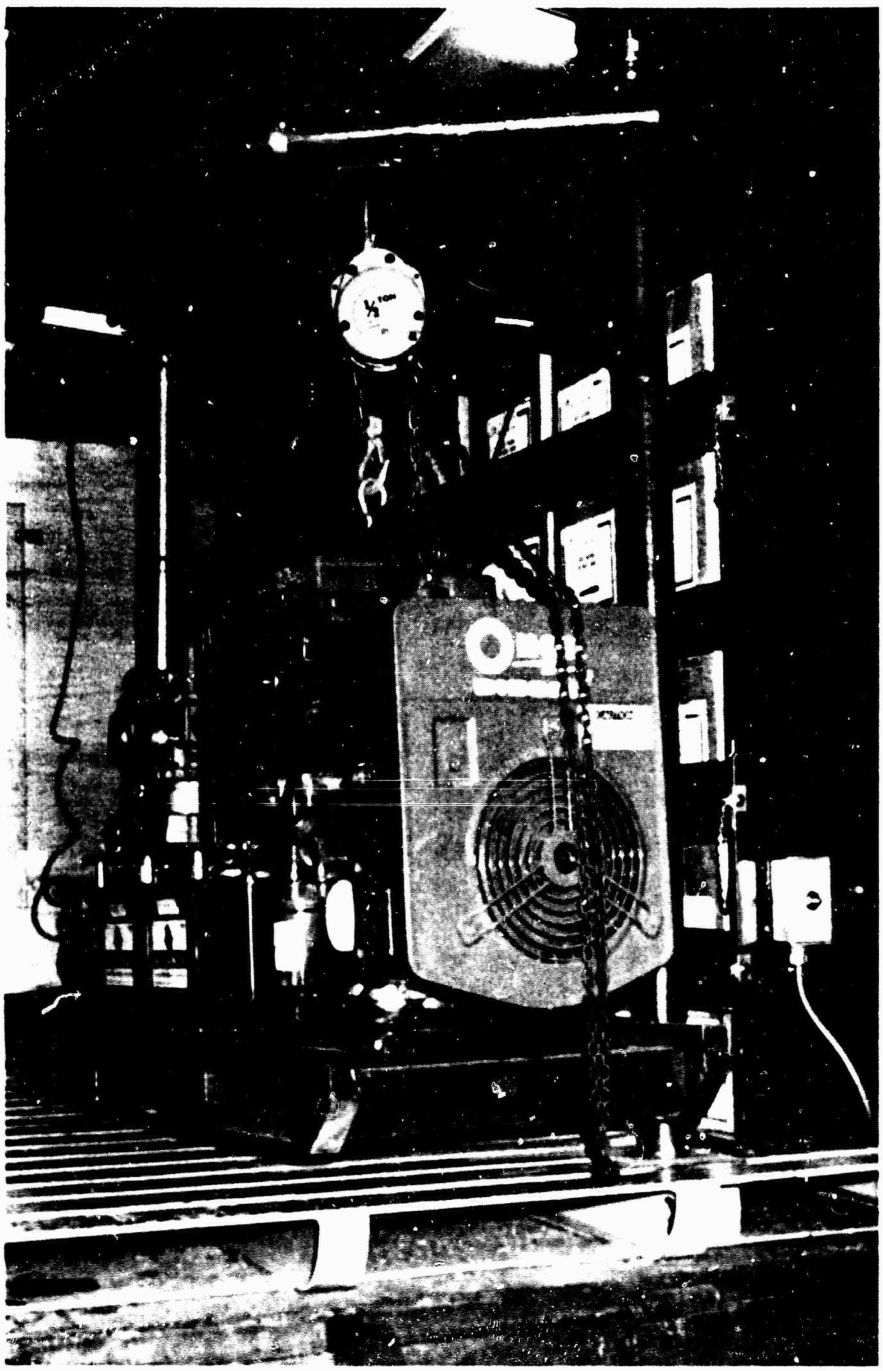


Figure 12. Generator.

in the military system. One is now under development by the Army and can be substituted with minor modifications once it becomes available.

Lighting Fixtures: The lighting fixtures were a standard stock item (6210-00-548-0222). There were four overhead fixtures (two on each side) attached to the bows supporting the canvas cover on the truck. Each fixture had two white flourescent tubes for normal use and either a blue/green or red tube for blackout conditions. Each tube draws 20 watts (Fig. 7).

OTHER

Storage cabinets: The storage cabinets for the Tray Packs, disposable serviceware, and cleaning materials were constructed from 3/4" plywood and provided approximately 55 cubic feet of storage space. The Tray Packs were stored in the cabinets on the right side of the vehicle, and the disposable serviceware and miscellaneous materials on the left side in cabinets A and B (see Fig. 13 and 14).

Optional Dining Equipment:

(1) Tent: A 16' x 16' frame-type tent providing space for four tables and eight benches was made available to the Air Force for the exercise.

(2) Tables and benches: Four tables and eight benches were provided for dining purposes. Both are commercial items by Correll, Inc. The tables were the folding-leg type with honeycomb core and high pressure plastic surface, each measuring 72" x 30" x 36". The benches measure 72" x 15" x 17".

IN-HOUSE TEST AND EVALUATION

In early September the unit was completed (see Fig. 14, and 15). The system was subsequently tested (on and off-road) under a Product Assessment Review (PAR) at the (Army) Sudbury Annex test facility. Upon successful completion of the PARs, the unit was carefully packaged and shipped to Utah by commercial carrier. The truck arrived at Dugway Proving Ground on schedule, 29 September, 1982, ready to participate in field exercises.

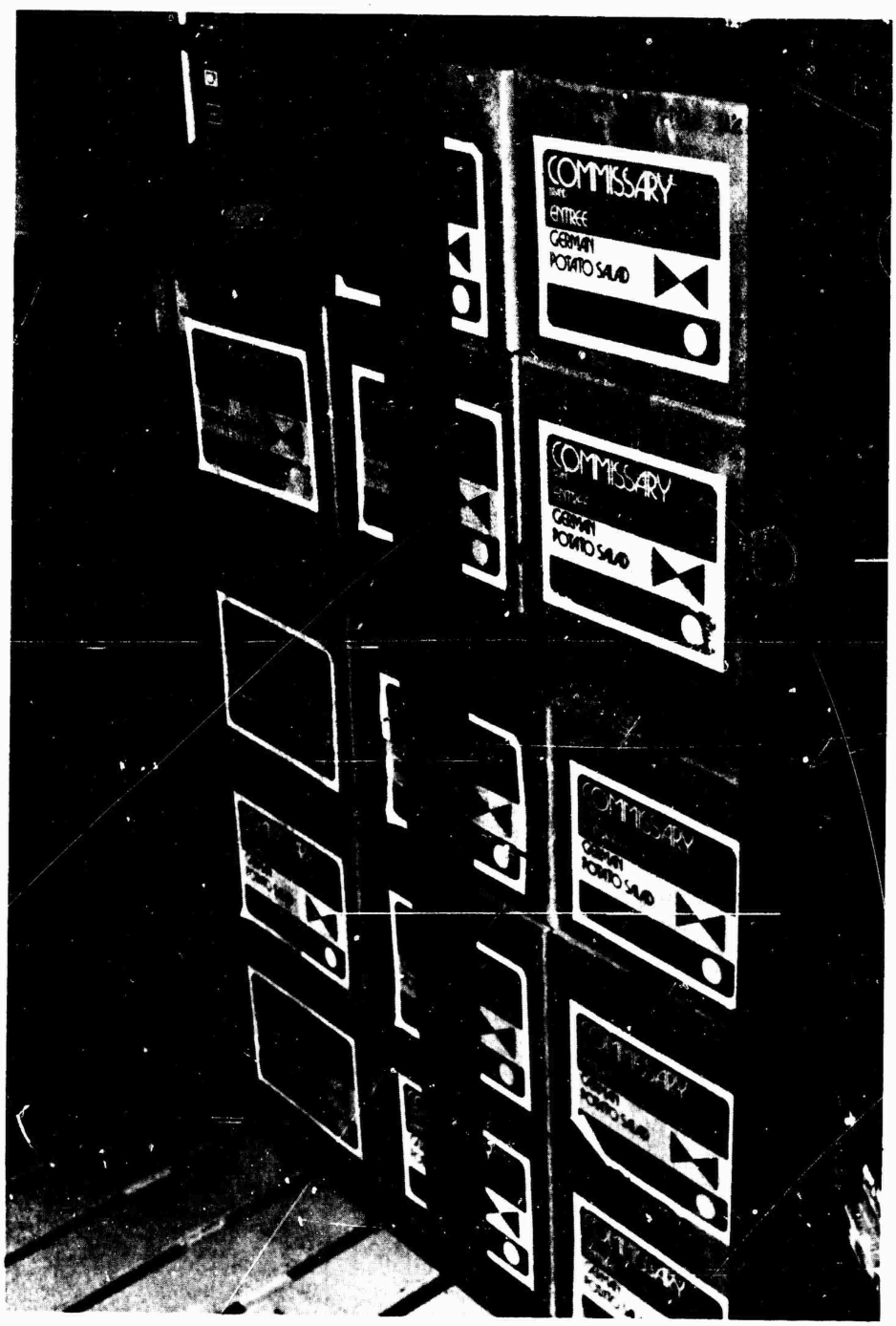


Figure 13. Storage cabinets.

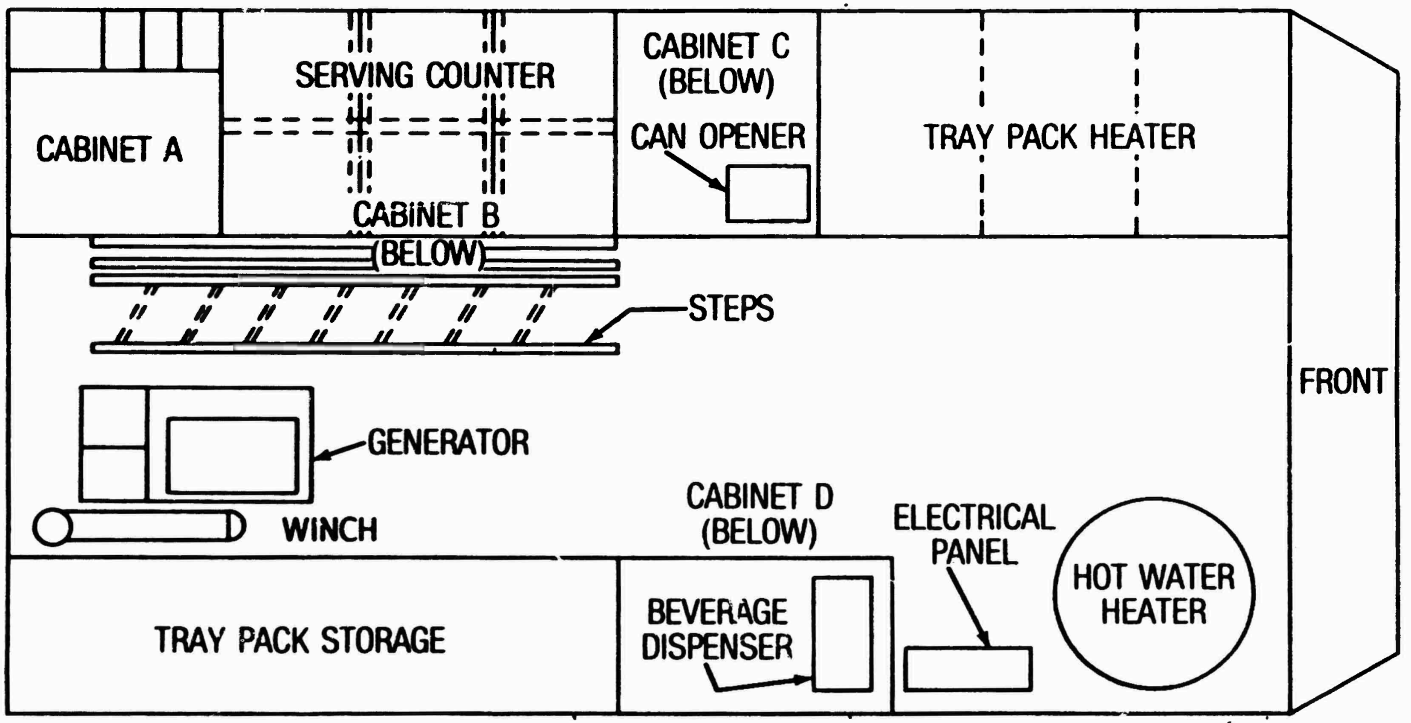


Figure 14. Food service system equipment layout -- over-the-road configuration.

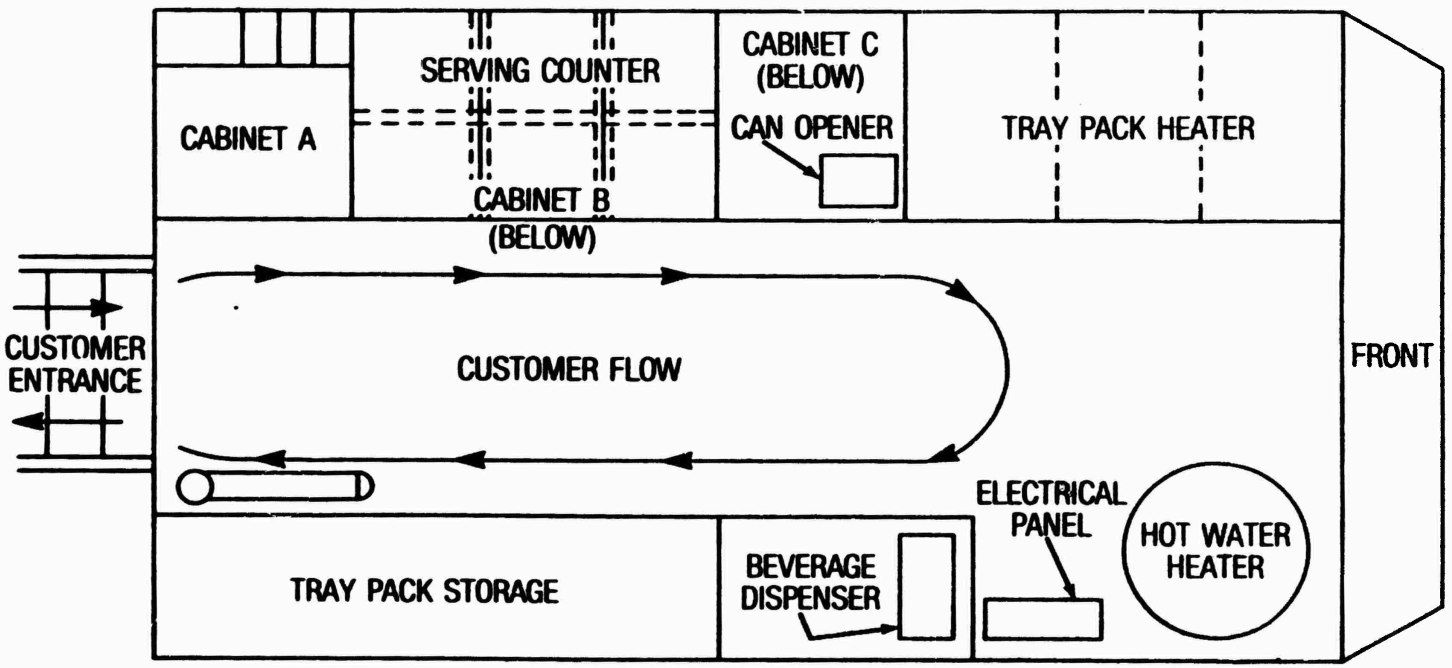


Figure 15. Food service system equipment layout -- serving configuration.

SECTION IV

LOGISTICS PLANNING AND SUPPORT

During the prototype construction period, concurrent efforts were underway to provide subsistence and equipment support for the upcoming field tests. Natick worked closely with GLCM supply personnel at Dugway to determine exercise schedules and the necessary quantities of Tray Packs and MREs that would be required to support them. The Tray Packs, purchased by Natick, and the MREs, purchased by the Air Force, were prepositioned at Dugway and Ft. Lewis.

A 30-day menu (reference Appendix B) was developed around commercially available Tray Packs. In selected categories, such as starches and desserts, a number of items were produced in-house to supplement limited industry sources. These included carrots, Spanish rice, peaches, pound cake, and coffee cake. Because the concept called for a self-service system, anticipated portion sizes were adjusted upward. For hot beverages, individual packages of cocoa and coffee were purchased.

In the area of equipment support, a backup generator and hot water heater, along with respective service manuals, were purchased by Natick. A spare parts inventory of high mortality equipment was also developed and assembled. This material was prepositioned at Dugway through the end of December 1982 and then moved to Ft. Lewis for the January test.

As the purpose of the field exercises did not include testing the flight's ability to repair food service equipment, it was determined that standard operating procedures would call for 100% replacement of the generator or the hot water heater in the field if either unit failed. Repairs would be performed at the MOB. Fuel, oil, and water requirements were provided to flight supply personnel for appropriate purchasing action.

Accessory items such as disposable serviceware, cleaning materials, etc., were identified, purchased by Natick, and stocked at Dugway and Ft. Lewis.

Additionally, rates of trash accumulation were estimated. GLCM logistics representatives determined that trash would be held with the flight and sent back to the MOB with the resupply convoys.

SECTION V

CONCEPT OF SYSTEM OPERATIONS

In addressing the requirement that the entire food service system would be managed and operated by non-food service personnel while in the field, Natick developed a set of operations manuals in the following key areas (reference Appendixes C, D, E, and F):

Food Service User's Manual	Medical Representative Guidelines
Flight Commander Guidelines	Logistics Support Manual

To highlight each briefly, the User's Manual was written to provide assistance to assigned personnel in the operation of the system. While explicit enough to guide even the most novice food service draftee, the preferred approach was to provide all flight personnel with an hour or two of training on the system. The principal areas covered in the manual included setting up the equipment, selecting and heating the food items, serving the meal, cleaning up the unit, and final inspection by the medic.

The Flight Commander Guidelines briefly explained how the system was intended to operate in the field. In addition, some optional items that were provided such as a dining tent, tables, and benches etc., were also covered. An increased emphasis was placed on the control of pilferable subsistence items, particularly the MREs.

Medical Guidelines suggested that the flight medic be on site before, during, and after meal service to monitor sanitation and food quality.

As the resupply function from the MOB was also coordinated by non-food service personnel, a specific Logistics Manual was developed to assist personnel in this task. The manual provided guidance on how to set up the main base food warehouse area. This included information on configuring initial flight loadouts and subsequent resupply convoys, monitoring Tray-Pack usage and acceptance, and accounting for quantities of food used. Resupply of disposable serviceware and other accessory items was likewise discussed in the guideline.

SECTION VI

FOOD SERVICE SYSTEM TEST & EVALUATION

The system test and evaluation was performed over a four-month period by the GLCM IOT&E Team and Natick. Phase I involved limited testing at Dugway Proving Ground, UT between 1 October 1982 and 14 December 1982. On 26 December the flight, including the food service vehicle, convoyed from Dugway Proving Ground to Tacoma, WA to participate in Phase II -- a 30-day (model mission) exercise at Ft. Lewis. Upon conclusion of this test, the food service vehicle was returned to Natick.

It is emphasized that Natick's primary objective during these tests was to insure that the system was viewed as compatible with overall mission requirements, exhibited a high degree of reliability, and, with minimal effort, offered a needed, quality, no-frills, hot meal in the field.

PHASE I - DUGWAY PROVING GROUND

As previously mentioned, the prototype food service system was required to be available for testing at Dugway Proving Ground by 1 October 1982. The vehicle was delivered prior to the 1 October deadline. On 12 October three members of the Natick team arrived at Dugway to unpack and assemble the system. Additional Natick personnel arrived on 13 October for discussions with GLCM test team members relative to Natick's participation in upcoming field tests.

To better familiarize the GLCM test team with the food service system, a sample Tray-Pack meal was served to all interested personnel, civilian and military. Participants were surveyed and asked to rate the meal and the overall system concept. As can be seen in the following table, the foods rated well. Where the civilian majority of this sample was unfamiliar with field food systems as such, their response on rating the overall system was disregarded.

TABLE 5. Demonstration Meal Ratings.

Tray-Pack Item	Rating*
Lasagna	7.6 (n = 27)
Roast Beef	7.8 (n = 24)
Stuffed Peppers	7.8 (n = 24)
Scalloped Potatoes	6.8 (n = 26)
Green Beans	7.0 (n = 29)
Apple Compote	7.5 (n = 29)

TABLE 5. Demonstration Meal Ratings. (cont'd)

Survey Questions	Yes	Moderately	No
1. Was your meal hot?	20	8	3
2. Was your beverage hot?	26	0	0
3. Overall, how would you rate this field food service concept?		Answer: 7.9	

*9-pt, hedonic scale, 1 = extremely bad -- 9 = extremely good

The three-month test phase at Dugway offered a number of opportunities for both the Air Force and Natick to evaluate the food service system under actual field conditions. Particular Natick test objectives included:

- ensuring acceptance of the system by the GLCM command staff;
- training GLCM personnel to operate the system;
- observing personnel and system performance characteristics under a variety of field conditions (very warm to very cold ,snow. weather);
- determining equipment reliability;
- evaluating concept acceptance and ease of operation by food service attendants;
- evaluating customer acceptance of both food items and the overall concept;
- evaluating disposable serviceware.

Air Force interests were very similar to those of Natick's with the following additions:

- would this food service system concept be compatible with overall mission requirements in the field?
- how would the unit integrate into the overall flight?
- what would be the impact on already limited personnel resources?
- how would the unit be best utilized in the field?
- as this is a self-supported system within the flight, would flight personnel perceive the benefits and therefore support the need for maintaining the unit?

Over the preceding three-month period numerous trips were made by Natick personnel to provide training and technical support, monitor food service operations in the field, and make equipment design modifications as necessary.

Realizing that a problem would exist involving early-on training needs, that is, all designated flight personnel would not be assembled and on site at Dugway until December, two airmen and one backup person were nevertheless selected and trained in the operation and maintenance of the system. These people in turn cross-trained a number of other personnel to operate the system. This situation was not viewed favorably by Natick as there was a good likelihood that these individuals would not be the same people that would

later accompany the flight into the field. In early December however, fourteen new personnel were trained. This group consisted of seven maintenance and seven defense force personnel, all of whom were scheduled to go with the flight to Ft. Lewis in January.

Natick-sponsored training consisted of a one-hour review of the User's Manual followed by audience questions. This level of training was consistent with overall design objectives that the system be simple to operate. With or without this review, any responsible person would have been able to read the manual and put out a proper meal.

Field exercises in October and November were usually limited to two or three days duration. During this time, the food service vehicle provided support to partial crews involved in field testing various subsystems of the flight. Natick observed a limited number of these exercises, relying substantially on after-the-fact feedback from designated GLCM personnel. Communications between Natick and the test team were excellent in this regard. The most comprehensive test occurred in early December when the entire flight (now assembled) participated in a field exercise. The weather was cold, usually only reaching the freezing point by midday. The ground was snow covered. This was the first good opportunity to observe customer arrival, waiting, service (see Fig. 16), and eating patterns. Team observers concluded that no problems existed in customer access or use of the food service system. They noted that customers arrived at staggered intervals, singularly or in small groups of two or three. There was some feeling on the part of the Natick team that customers were taking longer to get their food than was necessary, however, at this point these delays were attributed to the novelty of the system and the food products. Food service attendants were additionally observed while operating the system. Again, no problems surfaced regarding operations.

Equipment observations and modifications accounted for the better part of Natick's time and efforts during scheduled Dugway visits. The first items to be modified were the three insulated Tray-Pack containers on the serving line. As the weather proceeded to get colder, it became apparent that food holding temperatures on the serving line were deteriorating at an unacceptable rate. Natick engineers redesigned the serving line by eliminating the insulated Tray-Pack holders and replacing them with a stainless steel unit. The new unit was designed with three back-hinged stainless steel covers, accommodating the same six opened Tray Packs as the previous system. The principal difference was that a canned fuel, such as Sterno (registered TM), would now be used under the Tray Packs to keep them hot (see Fig. 17). While the modification proved to be quite successful in maintaining Tray-Pack temperatures on the serving line, even in below freezing temperatures, this was not considered a final solution. Had more time been available, the preferred approach would have been to run hot water from the hot water heater through a coil under the Tray Packs on the serving line, but such an extensive on-site modification was impossible.

In a second modification, resulting from on-going in-house work pertaining to MFSU heat losses, Natick personnel installed insulation on the Tray-Pack heater and on the water hoses between the Tray-Pack heater and the water heater. Adding the insulation resulted in a considerable improvement in

Figure 16. Customer leaving food service vehicle.

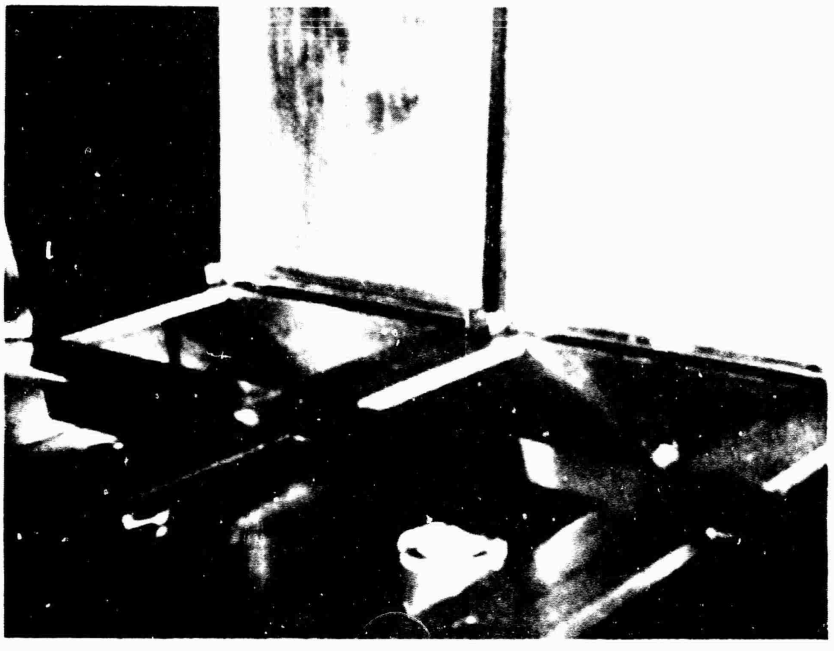


Figure 17. Tray-Pack serving line.

reducing heat-up times. Residual water temperatures in the Tray-Pack heater were now averaging 90°F to 100°F in the early mornings before startup, where prior to installing the insulation temperatures in the heater corresponded to outside temperatures, that is, at or below freezing.

The reality of below freezing temperatures at Dugway became the basis for the third system modification. A safe antifreeze solution had to be found to prevent freeze-ups in the boiler, hoses, and Tray-Pack heater. Draining the entire system to prevent freeze-ups was considered as the least desirable alternative. Repeated demands of this amount on the flight's overall water supply could possibly result in spot shortages between resupply intervals. After investigating the available alternatives, it was determined, in conjunction with the Air Force Veterinary Staff Officer at Natick, that a 50/50 solution of propylene glycol and water would be used in the Tray-Pack heating system. This would afford protection against system freeze-ups down to -27°F (see Appendix G).

In a similar weather related problem, water lines were frequently freezing in the hot beverage unit. Natick engineers consulted with Jet Spray factory representatives to determine if there was any way to drain, replace, or eliminate the solonoid valves that were retaining small amounts of water and subsequently freezing overnight. This, and other efforts to identify a commercial hot beverage unit that had the required capacity to support the flight and would operate in below freezing temperatures, proved unsuccessful. Natick engineers then set about designing and building a simple, stainless steel unit that would provide the needed capacity and not exceed the 1.5-kW electrical requirement. The unit was designed with a petcock at the base of the reservoir to allow for complete drainage of all the water in the system at the end of the day. The average amount of water discarded seldom exceeded the three quarts that were captive in the safety zone of the dispenser, that is, the amount of water between the bottom of the reservoir/heater and the draw-off valve. The unit was intentionally designed as such to prevent heater burnout should customers draw off all the water in the unit and forget to refill it. The new unit was in place and functioning at Dugway by mid-December (see Fig. 18).

This marked the final on-site modification; the entire system was operating perfectly and was ready to convoy to Ft. Lewis to participate in the month-long "model mission" exercise. Reference Appendix H for additional equipment description and performance data.

PHASE II - FT. LEWIS

A unique situation existed for the IOT&E Team in that the food service unit was not as yet considered an operational element of the flight and that the Test Director was obligated to conduct the "model mission" following prescribed operational procedures. The Test Director determined that mission procedures would be carried out to the extent that they did not compromise the health and well being (morale) of flight personnel in the field. The food service vehicle would therefore not participate in the test if, or until, such time as the Flight Commander determined that his people required a hot meal. On the third day of the exercise a request came in from the field to send the

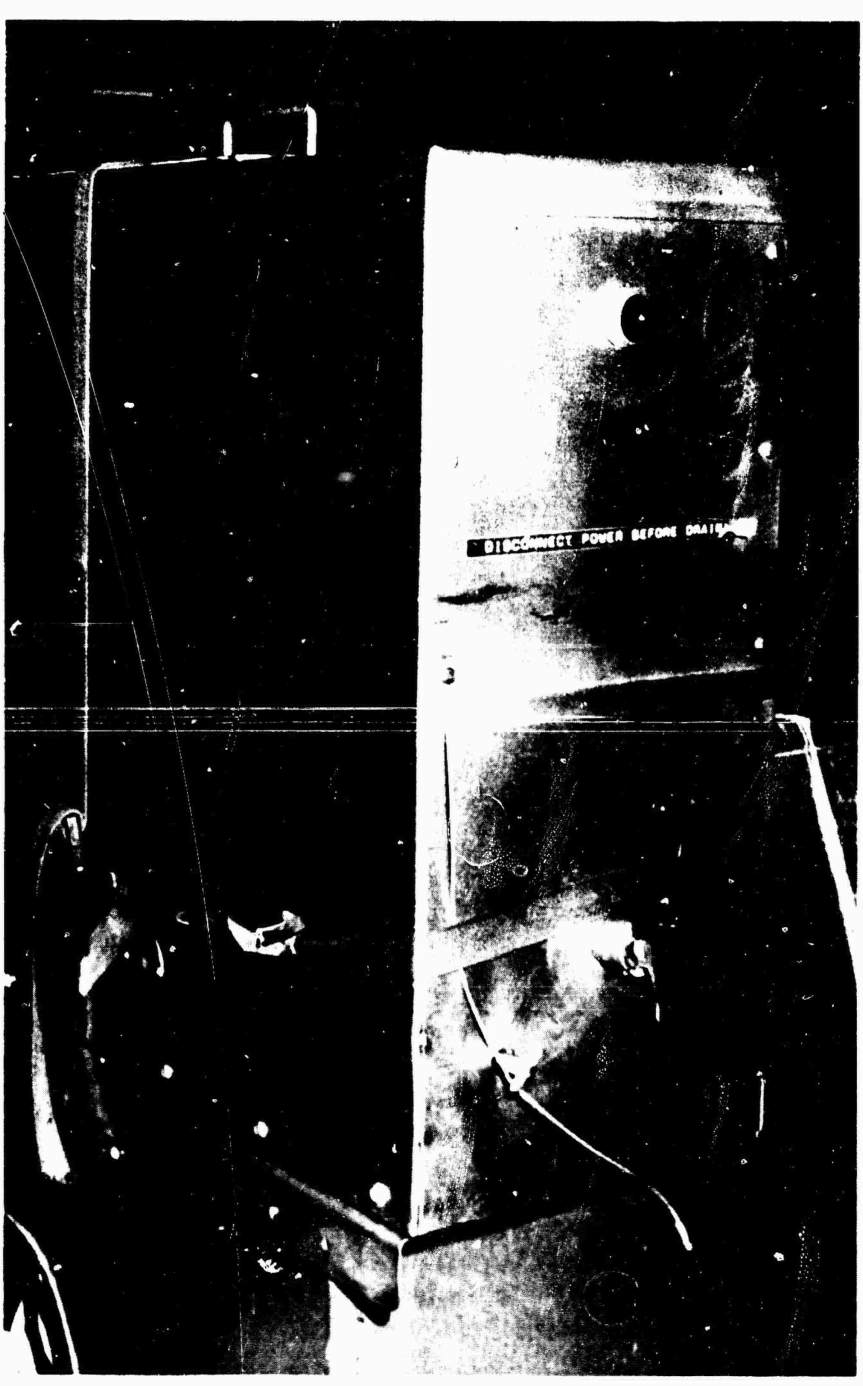


Figure 18. Hot beverage dispenser.

food service vehicle out to the flight the following day, serve a meal, and then return to the MOB. This procedure was similarly repeated on day five. On day six, the vehicle permanently joined the flight in the field for the duration of the exercise.

The two days that the vehicle went out to the flight to feed and return to the base provided GLCM personnel and Natick with an opportunity to test heat-on-the-move capabilities. On both days the system was loaded at the MOB and started (lit off) prior to departing the base so that hot food would be available on arrival at the field site. The unit performed flawlessly on the move. This included speeds of up to 55 mph over paved roads and lengthy travel over unimproved dirt roads (worsened by continual heavy rains).

Due to the nature of the "model mission" exercise, access to the flight in the field for data collection purposes was severely restricted. The following outlines Natick's limited opportunities to observe food service operations in the field.

Data Collection Periods	Data Collection Opportunities
January 4-10	January 5, 6, 8, 9
January 22-28	January 22, 24, 25, 26

Between the January 4-10 and January 22-28 data collection period, Natick relied on designated GLCM POCs for feedback on the food service system.

Test Results

A. Systems Operations

No noteworthy problems were observed in the overall food service operation. Obtaining time measurement data on various aspects of the system was frustrated by the fact that the meal period became a time for rest and socialization. Therefore, it is felt that this data could only improve if flight personnel had been more expeditious in their utilization of the system. Natick consistently observed two men manning the system during meal times; aside from the initial setup period, this was viewed as unnecessary. As stated in the User's Manual, only one person is required to monitor the system during meal times.

1. Serving Rate Times: Serving rates averaged 2.7 minutes per customer. This was the mean time for a customer to enter the system, pick up a paper plate, beverage packet, cup, etc., serve himself an entree, starch, vegetable and dessert, draw off a cup of hot water, and exit the vehicle. While this rate can be viewed as unnecessarily slow when compared to typical A Ration line throughput rates, it should be emphasized that no more than two customers were allowed in the truck at any one time to serve themselves. Nevertheless, time spent in the truck in this regard could have been reduced.

2. Meal Participation Rates: This data was recorded during six meal periods over the course of the exercise (see Table 6). Note that given the 24-hour a day nature of the exercise, a number of people would not be expected to attend the midday meal, as they had been up the night before and were now

trying to sleep. Based on historical field feeding attendance rates generally averaging around 50% (all services), the GLCM rates were viewed as very positive.

TABLE 6. Meal Participation Rates.

Date	Total Personnel	Avg. Personnel Served	Avg Percent Participation
Jan 4-10	68	52	76.5%
Jan 22	68	40	58.8%
Jan 24-28	82	58	70.7%

3. Eating Time Rates: The average time customers took to eat their meal was 13.9 minutes. Again, this period was used by a number of flight personnel to rest and socialize. Additional customer and food service attendant data can be seen in Section VII.

4. Food Service System Setup/Breakdown Times: Natick personnel questioned food service attendants on both the actual and estimated fastest time to set up the system (meal response time) and to break down the system in an emergency (road-ready time). In both cases the actual and estimated times were within the specified system requirements -- i.e., 1 hour "meal response" time and 15 minutes "road-ready" time.

5. Optional Test Equipment: While not an approved part of the food service system, Natick did provide four folding tables, eight folding benches, and a 16' x 16' tent that could be used for dining purposes. Use of these items was totally at the option of the flight. As it was, some of the tables and benches were seen to be in use whenever Natick personnel were in the field with the flight. The tent, however, despite the terrible rainy weather, was never used. When queried, flight personnel were just not willing to camouflage still another item, regardless of the payback. Since the food service vehicle (not having any assigned food service personnel) was not any one person's direct responsibility, the issue of camouflaging the unit was viewed as some inconvenience by those performing the task. In the last few weeks of the exercise, flight personnel simply rolled the camouflage material on top of the vehicle when relocating.

B. Equipment

All food service equipment functioned throughout the test with no mechanical failures or downtime. Prior to the food service vehicle permanently joining the flight in the field, a minor problem surfaced with the 3-kW generator. The Natick equipment representive determined that the lift bar assembly had not been properly secured to the generator body and was coming in contact with a solenoid on top of the generator and blowing fuses. As soon as the lift bar was properly secured and the fuse replaced, no further problems were experienced.

Mean Tray-Pack and beverage water temperatures can be seen in Table 7. These temperatures were viewed as adequate by Natick personnel with data in Section VII, substantiating customer satisfaction in this area.

TABLE 7. Mean Tray-Pack and Beverage Temperatures.

Meal Component	Mean Temperature (^{o}F)
Entrees	129^{o}
Starches	128^{o}
Vegetables	123^{o}
Desserts	129^{o}
Hot beverage water	189^{o}

The night light system on the food service vehicle was frequently used during the exercise by flight personnel. Natick provided both red and blue/green filters for testing. GLCM personnel determined that the red filters were preferred over the blue/green for night operations. This decision was to be later reversed.

C. Medical/Sanitation Observations

At each available opportunity Natick evaluated the maintenance/sanitation of the food service system. Without hesitation it can be said that the overall cleanliness of the unit was exceptionally good. This was a particularly interesting observation in light of the all-volunteer nature of the system. The only area that deserved more detailed attention was the cleanliness of the serving line during meals. Food service attendants could have wiped up spills on the serving line more often.

In an interview with the flight medical representative on our final departure day the question of any reported illness or problems traceable to or suspect of the food service system was addressed. No problems of this nature had been observed by the medic.

PROJECT SUMMARY

In May 1983, a meeting was convened at Natick to finalize the system design and to develop strategies for meeting near-term IOC deadlines and future procurements.

A draft Statement of Need was presented for Air Force review. It was agreed that the project would transition to FEL (6.4) in FY84, and 85 for final system design modifications and development of a Technical Data Package with first production buy responsibility.

All design changes that were discusssed and agreed to have been successfully incorporated into the new design. The rebuilt prototype unit has since been delivered to Davis-Monthan AFB, AZ to join the GLCM flight

scheduled for deployment to Sicily, Italy. A second prototype under construction is scheduled for delivery to Greenham Commons, England. All remaining units required to support future deployments will be produced under contract by the Air Force.

In summary, the GLCM Food Service System offers a new capability for the user by providing a tailored means of heating Tray Packs. It also offers significant potential benefits to the military by reducing the number of personnel required to deliver hot meals in an isolated and potentially hostile field environment.

The project has subsequently been awarded the Technical Director's Engineering Award and the Kohland Isker Award for national preparedness in the areas of food and containers, sponsored by the Research and Development Associates for Military Food and Packaging Systems, Inc.

SECTION VII

CUSTOMER AND FOOD SERVICE ATTENDANT DATA

During the January 1983 test at Ft. Lewis, WA, data were collected from both customers and food service attendants concerning the acceptability of the GLCM food service system. To avoid overloading the relatively small GLCM flight with too many surveys and interviews, data gathering efforts were confined to the second and fourth weeks of the exercise. Both the customers and food service attendants had been exposed to the system in previous short field exercises at Dugway Proving Ground, UT.

METHOD

Since the environmental conditions were anticipated to be adverse (cold and wet), very short surveys and interviews were designed. The tactical nature of the exercise further required that surveying and interviewing occur only during the meal period and at the food service site. Copies of all of the survey and interview instruments used can be found in Appendix I.

CUSTOMER FOOD ACCEPTANCE INTERVIEW

The original plan for this test was to hand out a single food acceptance survey sheet to as many customers as possible at each meal where data were to be collected. The rainfall was, however, too frequent and intense, soaking all available writing surfaces. An alternative procedure was therefore developed whereby the Natick psychologist retained the form on a clipboard, showed it to each interviewee, and filled out the answers for them. Customers were approached by the interviewer immediately after they completed their meal. A total of 196 food acceptance interviews were collected in both the second and fourth weeks of the exercise (see Table 8). Each customer was asked to rate the overall acceptability of the Tray-Pak meal he had just eaten, the acceptability of each food item in the meal, the temperature of each food item in the meal, and the overall acceptability of his most recently consumed MRE. It would have been preferable to obtain MRE acceptability ratings just after they had been consumed, but this was precluded by the tactical requirements of the exercise.

TABLE 8. Number of Food Acceptance Interviews.

6 Jan	-	30
8 Jan	-	31
9 Jan	-	32
22 Jan	-	31
24 Jan	-	23
25 Jan	-	34
26 Jan	-	15
Total		196

CUSTOMER OPINION SURVEY

A single page customer opinion survey was administered to a total of 45 GLCM flight customers in the fourth week of the field exercise. Surveys were attached to clipboards and handed to customers just after they had completed their meal. The survey asked the customer to rate Tray-Pack and MRE meals overall with respect to quality, quantity, variety, temperature, and ease of preparation/serving. Finally, they were asked if they preferred a food service system with three MRE meals, or one Tray-Pack and two MRE meals, or two Tray-Packs and one MRE meal.

CUSTOMER INTERVIEW

After completing the opinion survey, all but one customer was given a short interview. The interview asked about additions to and deletions from the GLCM food service menu, recommended changes in the GLCM food service system, problems in getting to the feeding site at mealtimes, availability of hot beverages, comments on the MRE, adequacy of the water supply, and desirability of having a dining tent.

FOOD SERVICE ATTENDANT SURVEY

Seven food service attendants were surveyed in the fourth week of the field test. As described in an earlier chapter of the report, these attendants were not professional food service personnel and had received only minimal training in the operation of the food service unit. Attendants were asked to rate the GLCM food service system overall, to rate different aspects of the kitchen, to rate the ease or difficulty of several GLCM food service system operational factors, and to register their preference about food service being an additional or exclusive duty position.

FOOD SERVICE ATTENDANT INTERVIEW

The same seven attendants were interviewed following completion of the survey. Questions concerned likes and dislikes about the food service unit, recommended changes in the system, problems with equipment and supplies, recommended alterations in equipment location, and desirability of having a dining tent.

RESULTS AND DISCUSSION

In general, the results from the field test can be summarized by stating that both customers and food service attendants responded very favorably to the GLCM food service system.

CUSTOMER FOOD ACCEPTANCE

Table 9 shows the overall meal ratings for both Tray-Pack and MRE meals. The mean of 7.36 on the nine-point hedonic scale for Tray-Pack meals falls between "like moderately" and "like very much", and is quite high relative to other data collected in the field feeding context. The mean rating for MREs of 5.85 (between "neither like nor dislike" and "like slightly") is lower but better than data on the Meal Combat Individual collected in previous field exercises. The MRE ratings are not directly comparable to the Tray-Pack

ratings since customers rated "presently eaten" Tray Packs and the "most recently consumed" MRE.

TABLE 9. GLCM Food Acceptance -- Overall Meal Ratings.* (n = 196)

Tray Pack	MRE
7.36	5.85

*Not directly comparable since subjects rated presently eaten Tray Pack and most recently consumed MRE.

Rating Scale: 9 = Like Extremely
5 = Neither Like Nor Dislike
1 = Dislike Extremely

Tables 10 and 11 show ratings for all of the individual Tray-Pack food items consumed on the days testing was carried out. All entrees and starches were given a mean rating of 6.00 or higher; only one vegetable, stewed tomatoes, had a mean rating below 6.00 (and it was rated by only three customers); desserts were given ratings of 6.85 or higher.

In the interview, customers were asked if they would like to delete any items from the Tray-Pack menu. Only one item was suggested as a deletion by more than five customers. This entree, stuffed peppers, while suggested as a deletion from the menu by 30% of the interviewed, was given a mean acceptance rating of 6.77 on the nine-point hedonic scale (see Table 10). It seems that those individuals who liked stuffed peppers liked Tray-Pack stuffed peppers. It perhaps would not be a good choice for a single entree menu, but is acceptable on a menu where more than one choice is offered.

The question concerning the acceptability of the serving temperature of the Tray-Pack items was almost universally answered "just right". The extremely infrequent responses of the "too cold" variety were given to vegetable items, but were too infrequent to elicit concern (less than ½ of 1%).

CUSTOMER OPINION OF THE GLCM FOOD SERVICE SYSTEM

Combining the results from the customer surveys and interviews provides a picture of positive customer perception of the GLCM food service system. Table 12 shows mean seven-point scale ratings of several aspects of the Tray Packs and MREs. Customer overall reactions to Tray Packs were higher than that of the MRE (a mean of 5.61 compared to 5.04), although the latter is not "unacceptable" falling in the "slightly good" category. Customer perceptions of other characteristics of the Tray Packs -- quality, quantity, variety, serving temperature, and ease of service -- all fell between "slightly good" and "moderately good". The lowest rated characteristic, at 5.04 on the seven-point scale, was variety. This was the only ration characteristic on which Tray Packs were not rated statistically higher than MREs.

TABLE 10. GLCM Food Acceptance --
Individual Entree and Starch Mean Ratings.

Entree	Mean	No. of Customers
Chicken Breasts	8.00	47
Lasagna	8.00	7
Salisbury Steak	7.97	38
BBQ Beef	7.50	8
Roast Beef	7.32	19
Ham and Potatoes	7.03	35
Chili	7.00	33
Chicken Cacciatore	7.00	6
Beef Stew	6.95	41
Stuffed Peppers	6.77	17
Stroganoff	6.00	15

Starch	Mean	No. of Customers
Macaroni & Cheese	7.33	19
German Potato Salad	6.92	13
Spanish Rice	6.62	26
Stew Cut Potatoes	6.05	38

Rating Scale: 9 = Like Extremely
5 = Neither Like Nor Dislike
1 = Dislike Extremely

TABLE 11. GLCM Food Acceptance --
Individual Vegetable and Dessert Menu Ratings.

Vegetables	Mean	No. of Customers
Corn	7.23	13
Peas	7.18	56
Lima Beans	6.33	12
Carrots	6.33	6
Green Beans	6.10	20
Stewed Tomatoes	4.33	3

Dessert	Mean	No. of Customers
Pound Cake	8.05	21
Cherry Compote	8.00	39
Blueberry Compote	7.48	47
Apple Cake	7.36	11
Peach Compote	7.32	22
Peaches in Syrup	7.32	19
Apple Compote	6.85	20

Rating scale: 9 = Like Extremely
5 = Neither Like Nor Dislike
1 = Dislike Extremely

TABLE 12. GLCM Customer Survey --
Tray-Pack and MRE Characteristics.
(n = 45)

	Tray Pack	MRE	t Test Statistic
Overall Reaction	5.61	5.04	p<.01
Quality	5.48	4.83	p<.002
Quantity	5.69	4.26	p<.001
Variety	5.04	4.87	NS
Serving Temperature	5.65	3.73	p<.001
Ease of Serving Self	5.89	4.49	p<.001

Rating Scale: 7 = Very Good
4 = Neither Bad Nor Good
1 = Very Bad

In general, MRE ratings were one scale point lower than Tray-Pack ratings. Nevertheless, only one characteristic of the MRE, serving temperature, was rated below the 4.00 "neither bad nor good" level. The customer interview sheds some light on that response. Only 1/3 of the customers reported trying to heat the MREs most of the time. The others commented that it took too long and was particularly difficult when on the move. A specific complaint raised by several customers was that the glue from the MRE packet dissolved into the hot water in their canteen cup when they attempted to heat the MREs as instructed.

The MRE characteristic with the second lowest rating was quantity, and the interview responses helped to pinpoint the perceived problem. The entree portions were seen as being too small by 27% of the subjects; a significant number of open-ended responses. Portion size was probably the main factor in the overall quantity ratings.

Customers were also asked to indicate their preferred mix of MREs and Tray Packs in the GLCM system. As can be seen in Table 13, they strongly preferred one Tray-Pack and two MRE meals per day to three MRE meals (81% to 7%). The sentiment was not present, however, to increase to two Tray-Pack meals. Only 38% preferred two Tray Packs a day, while 33% preferred one, and 29% had no preference.

TABLE 13. GLCM Customer Survey --
Preferred Mix of Tray Packs and MREs.
(n = 45)

Alternative 1	Response
2 MREs and 1 Tray Pack	81%
or 3 MREs	7%
No preference	12%
Alternative 2	
1 MRE, 2 Tray Packs	38%
or 2 MREs, 1 Tray Pack	33%
No preference	29%

Customers also reported no problem getting to the feeding site to eat, and no problems with water availability.

Most customers (64%) suggested no changes for the GLCM food service system (see Table 14). Some (20%) requested that the food service vehicle be modified so that customers could walk through and exit from the side. This modification, however, would violate the constraint of not altering the GLCM vehicles. Another 11% suggested that there be more space in the kitchen.

TABLE 14. GLCM Customer Interview --
Changes in the GLCM Food Service System.
(n = 44)

Changes in Food Service System?	
None	64%
Walk-through Kitchen	20%
More Room in Kitchen	11%
Tent to Eat In?	
No	59%
Yes	34%
Only in Bad Weather	7%

Most customers (59%) also vetoed the idea of having a tent in which to eat. In general, they felt that the amount of work involved in erecting and camouflaging a dining tent was not worth it. Six of the seven food service attendants likewise expressed no interest in a dining tent for the same reason.

In the interview, customers were asked if they preferred to see any food items added to the GLCM food service menu. Table 15 shows the responses of customers both to the open-ended general question and to subsequent probes about specific items. The non-probed responses are quite high for open-ended, volunteered answers, and the final combined open-ended and probed responses speak for themselves. Customers clearly prefer the addition of bread, fresh fruit, milk, and soft drinks. The volunteered suggestion of spaghetti as a Tray-Pack item is perhaps also worth consideration. Even though salads are a high preference item, 59% of the customers felt that they should not be served in the GLCM field situation.

TABLE 15. GLCM Customer Interview -- Items to be Added to the GLCM Menu.

	Percentage of Volunteered Responses	Percentage of Volunteered Plus Probed Responses
Bread	25%	93%
Fresh Fruit	36%	89%
Milk	41%	86% *
Soft Drinks	14%	57% *
Spaghetti	11%	-

* The probe was "beverages"

Should salads be added to the GLCM menu?

Yes - 41%
No - 59%

In a related question, customers were asked whether hot beverages (coffee/hot chocolate) should be made available other than with the Tray-Pack meal. Twenty-six of the 44 customers interviewed (59%) expressed a desire for increased availability of hot beverages. Many of the 41% who said no were concerned with the potential tactical problem of concentrating personnel near the food service vehicle.

FOOD SERVICE ATTENDANT OPINION

Table 16 shows mean responses from the seven attendants surveyed concerning the GLCM food service system. First, note that their overall impression of the system is quite good (5.86 on a seven-point scale) and their overall evaluation of the kitchen is likewise favorable. Lighting, roof height, type, and amount of equipment, noise, sanitary conditions, and

temperature all received mean ratings of slightly good or higher. Attendants expressed some concern with the ease of getting at supplies, and a more serious level of concern with the amount of storage space, and bumping into other people in the unit. When asked what changes they would suggest be made in the system, their response addressed some concern with the work space and bumping into people. They suggested moving the coffee/hot water equipment to the rear of the truck, thereby relieving some congestion in the forward portion of the serving area.

Table 17 contains the attendants' mean responses concerning the ease or difficulty of operating the GLCM food service system equipment. Essentially they complained about two aspects only: cleaning the serving line and camouflaging the vehicle. Fifteen other operational steps were judged to be easy to carry out.

TABLE 16. GLCM Attendants Survey --
Food Service System Evaluation.
(n = 7)

Overall Impression of System	5.86
Kitchen Overall	5.43
Lighting	6.14
Height of Kitchen Roof	5.86
Type & Amount of Equipment	5.57
Noise	5.43
Sanitary Conditions	5.14
Temperature	5.00
Easy-to-Get-at Supplies	4.43
Amount of Storage Space	3.86
Amount of Working Space	3.71
Bumping Into Other People	3.57

Rating Scale: 7 = Like Extremely
4 = Neither Like Nor Dislike
1 = Dislike Extremely

TABLE 17. GLCM Attendants Survey --
Ease of Operating Equipment.
(n = 7)

Operate Hot Beverage Dispenser	6.71
Disconnect Electric and Fuel Connections	6.43
Make Electric and Fuel Connections	6.29
Start Generator	6.29
Operate Hot Water Heater	6.29
Load Tray-Packs for Heating	6.29
Open Tray-Pack Cans	5.86
Place Tray-Packs on Serving Line	5.86
Set Up Trash Bag	5.86
Place Tray-Pack Basket into Heater	5.57
Replace Generator on Truck	5.29
Clean Can Opener	5.14
Remove Tray-Pack Basket from Heater	5.00
Clean Floor	5.00
Offload Generator from Truck	5.00
Clean Serving Line	3.86
Camouflage the Kitchen Truck	3.86

Rating Scale: 7 = Very Easy
4 = Neither Hard Nor Easy
1 = Very Hard

Finally, questions were addressed to the food service attendants about their additional duty status. Perhaps not surprisingly, five out of the seven would have greatly preferred to be responsible for their primary duty only (see Table 18). The same five preferred the idea of having a cook or cooks assigned to the GLCM flights.

TABLE 18. GLCM Attendants Survey --
Should Food Service be an Additional Duty Assignment?
(n = 7)

Prefer doing own job only or being food attendant also?

Own Job Only	-	72%	(5)
Neutral	-	14%	(1)
Attendant Also	-	14%	(1)

Prefer present system without cooks or having cooks assigned?

Without Cooks	29%	(2)
Cooks Assigned	71%	(5)

This document reports research undertaken at the US Army Natick Research and Development Command and has been assigned No. NATICK/TR-85/040 in the series of reports approved for publication.

APPENDIX A

FOURTEEN-DAY COMMERCIALLY AVAILABLE CANNED FOOD MENU

Fourteen-Day Commercially Available Canned Food Menu

Day 1
Sliced Beef in Barbecue Sauce
Whole Kernel Corn
Tropical Fruit Salad Dessert

Day 2
Chicken Stew
Green Peas
Butterscotch Pudding

Day 3
Spaghetti with Meatballs
Green Beans
Pineapple Chunks

Day 4
Beef Stew
Mixed Vegetables
Sliced Peaches

Day 5
Beef Hash
Whole Kernel Corn
Pears in Syrup

Day 6
Cream Thin Sliced Beef
Green Peas
Chocolate Pudding

Day 7
Macaroni and Cheese
Stewed Tomatoes
Tropical Fruit Salad

Day 8
Chili Con Carne with Beans
Cream Style Corn
Pineapple Chunks

Day 9
Macaroni and Beef
Green Peas
Ready-to-serve Rice Pudding

Day 10
Chicken a la King
Carrots
Applesauce

Day 11
Lasagna
Mixed Vegetables
Pears

Day 12
Corned Beef Hash
Green Beans
Chocolate Pudding

Day 13
Stuffed Cabbage Rolls
Carrots
Mixed Fruit

Day 14
Chili Macaroni
Green Peas
Peaches

APPENDIX B

GLCM TRAY-PACK MENU

GLCM TRAY-PACK MENU

Day 1
Beef Stew
Cut Potatoes
Green Beans
Peaches

Day 2
Stuffed Peppers
Macaroni & Cheese
Corn
Apple Compote

Day 3
Salisbury Steak
Spanish Rice
Peas
Cherry Compote

Day 4
Chili
German Potato Salad
Carrots
Pound Cake

Day 5
Chicken Breasts
Scalloped Potato & Ham
Lima Beans
Blueberry Compote

Day 6
Roast Beef
Cut Potatoes
Peas
Peach Compote

Day 7
Lasagna
Green Beans
Apple Compote

Day 8
Roast Beef
Macaroni & Cheese
Stewed Tomatoes
Coffee Cake

Day 9
Beef Stroganoff
German Potato Salad
Corn
Cherry Compote

Day 10
Chicken a la King
Cut Potatoes
Carrots
Peaches

Day 11
Beef Tips
Spanish Rice
Green Beans
Blueberry Compote

Day 12
Ravioli
Peas
Pound Cake

Day 13
BBQ Beef
Macaroni & Cheese
Stewed Tomatoes
Apple Compote

Day 14
Salisbury Steak
Baked Beans
Corn
Peach Compote

Day 15
Chicken & Noodles
Cut Potatoes
Carrots
Cherry Compote

Day 16
Stuffed Peppers
German Potato Salad
Green Beans
Coffee Cake

Day 17
Macaroni & Beef
Scalloped Potato & Ham
Peas
Blueberry Compote

Day 18
Chicken Cacciatore
Cut Potatoes
Corn
Apple Compote

Day 19
Roast Beef
Macaroni & Cheese
Stewed Tomatoes
Peaches

Day 20
Chili
Spanish Rice
Carrots
Pound Cake

Day 21
Lasagna
Peas
Blueberry Compote

Day 22
Chicken Breasts
Baked Beans
Green Beans
Cherry Compote

Day 23
Stuffed Peppers
Scalloped Potato & Ham
Carrots
Peach Compote

Day 24
Beef Stew
German Potato Salad
Corn
Coffee Cake

Day 25
Roast Beef
Spanish Rice
Peas
Apple Compote

Day 26
Ravioli
Green Beans
Blueberry Compote

Day 27
Stuffed Cabbage
Macaroni & Cheese
Corn
Cherry Compote

Day 28
Lasagna
Carrots
Pound Cake

Day 29
Chili
Cut Potatoes
Green Beans
Peaches

Day 30
Roast Pork
Scalloped Potato & Ham
Stewed Tomatoes
Apple Compote

APPENDIX C

GROUND-LAUNCHED CRUISE MISSLE
FIELD FOOD SERVICE SYSTEM

USER'S MANUAL

Prepared for Flight Personnel
by the
Directorate for Systems Analysis and Concept Development
US Army Natick Research and Development Center

Revised
1 November 1982

DISCLAIMER

This manual does not attempt to cover every conceivable aspect of operating the food service system. It is assumed that in such areas as operating the truck, fuel handling procedures in the field, detaching water trailers, etc., that fully qualified individuals will be performing these tasks.

INTRODUCTION

Because of the austere nature of the GLCM mission every effort has been made to minimize the number of people in a flight. Accordingly, food service personnel have been designated as "non-essential" and, therefore, will not be assigned to the flight during field exercises. Nevertheless, a need exists to provide hot meals in the field. A request was made to design and build a food service system for GLCM that could be operated by personnel with no food service experience, that was highly mobile, that could provide a quality hot meal on short notice, and that did not use any food items that required refrigeration or that tended to spoil easily.

Such a system has been designed and built and is ready to provide hot meals to flight personnel during field exercises. The system is mounted on a 5-ton cargo truck and has been designed to be easy to operate. This step-by-step User's Manual has been written to provide you with the necessary information to operate the system.

One final note. Handling food that other people will eat is a serious responsibility. We have every confidence that you will do the best job possible in serving the meal and in protecting others' health and safety.

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1. POSITIONING AND SET UP PROCEDURES

- Select a suitable feeding site.
- Disengage the water trailer (buffalo) from the truck.
- Drive the vehicle approximately 50 feet from the water trailer in a direction away from where people will group together to eat, sleep, etc.
- Drop the tailgate. Remove the railings and securing bolts from the stairs.
- Hang the stairs from the tailgate to the extreme driver's side. At this point do not install the railings.
- Remove the four wing nuts that secure the generator to the floor.
- Check the guidewire on the boom. DO NOT OPERATE THE BOOM IF THE GUIDEWIRE IS NOT SECURELY IN PLACE OR APPEARS WORN OR FRAYED.
- Hoist the generator up approximately 1/16". Slide the generator towards the middle of the truck to clear the back floor clamps. Once positioned in the middle of the truck, hoist the generator up 1". The woven strap on the boom should be tossed over the rear of the truck. Carefully swing the boom around until it is pointed directly out the rear of truck. Remove the safety pin from the boom arm. (CAUTION: Watch your fingers! The winch will slide quickly to the end of the boom.) Once the generator has moved to the end of the boom, turn the generator so that the batteries face outward. Lower the generator to the ground. Remove the winch chain from the generator. Stow winch chain in the storage bag that hangs from the boom arm. The boom can be left in the outward position if desired. Now remove the lift bar from the generator and secure it to the brackets located at the base of the generator.
- Place the diesel fuel can beside the generator and screw the drum-fill-adaptor assembly into the fuel can with the quick disconnect facing away from the handle. Now connect two fuel quick-disconnect lines (supply and return) from the generator to the fuel can.
- Place the stairs and railings back in truck. (No need to bolt down.)
- Drive the truck back to the water trailer.
- Remove the stairs from inside the truck and attach them to the rear of the vehicle, approximately in center position. Install the hand rails.
- Open the canvas side flaps for light and/or ventilation.
- Position the fuel can hanger on the outside passenger side of truck adjacent to the boiler. Screw drum-fill-adaptor assembly into fuel supply can, following the same procedure as used for the generator fuel

supply can. Secure the fuel can to holder. Connect two fuel quick-disconnect lines (supply & return) to the boiler.

- Uncoil the main power supply cable and connect to the power outlet of the generator and to the power inlet panel located inside the truck to the right of the boiler.

- At this time check the power panel to ensure that all circuit breaker switches are in the OFF position.

- Fill hot beverage dispenser reservoir with potable water. Be sure the reservoir is clean.

- Half fill the Tray-Pack heating tank with water. CAUTION: This tank is never drained once in the field. You only need to replace a few gallons of water each day due to evaporation and spillage.

- To start the generator depress and hold the preheat switch for 60 seconds, and then depress the start switch and release.

- Turn on the main circuit breaker switch located in the truck next to the boiler. At this time the two red pilot lights designated "MAIN" should be lit on the indicator panel. This indicates power is up to the panel. The circuit breaker for the overhead lights can now be turned on. The actual light switch is located at the back of truck (white lights up, red [night] lights down, middle position off).

- Open the 3 hand valves located on the Tray-Pack hot water tank (two valves underneath, and one to the right side).

- Turn on the circuit breaker marked "water pump". The indicator light and the pump should now be on.

- Turn on the circuit breake for the hot beverage unit. The indicator light and beverage heater should now be on.

- ENSURE THAT THE BOILER VENT STACK IS IN POSITION BEFORE STARTING THE BOILER.

- ENSURE THAT THERE IS SUFFICIENT WATER IN THE TRAY-PACK HEATER AND CHECK THAT ALL VALVES ARE OPEN PRIOR TO STARTING THE BOILER.

- Turn on the circuit breaker for the boiler. The indicator light and boiler should now be on.

2. LOADING THE TRAY-PACK HEATER

- Match the corresponding "mission day" with the appropriate day on the GLCM MENU. This will tell what food items to serve and how many Tray Packs of each type of food need to be heated.

- Using the lift hooks provided, remove the wire baskets from the Tray-Pack heater. See Figure C-1.

- Open the appropriate cases of Tray Packs. Load the specified number of Tray Packs of each item into the baskets.

- WARNING: If any Tray Packs are leaking, bulging, or have serious dents in them, call the Medic. Do not use those Tray Packs.

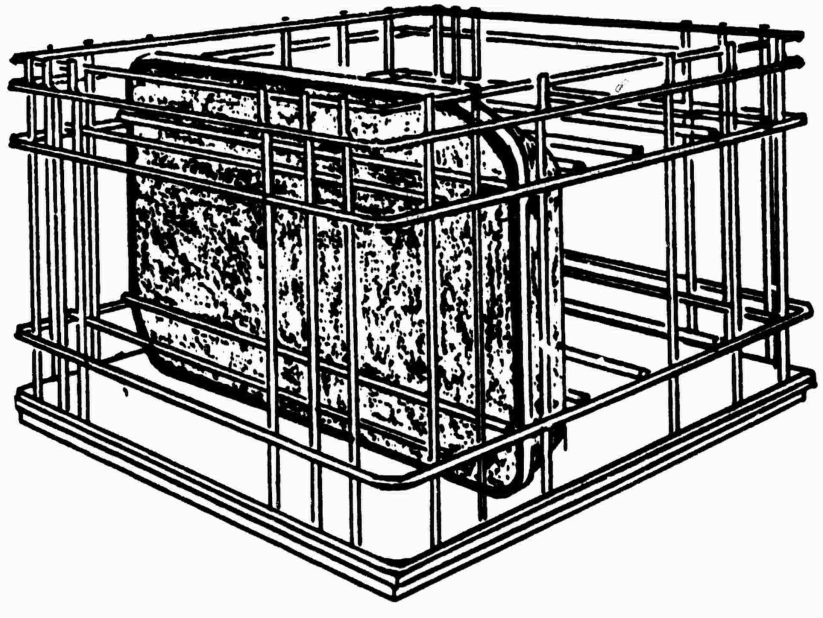

Figure C-1. Wire basket for heating tray packs.*
*Each basket holds 5 tray packs.

- Take two of the empty boxes that you have just opened and place them in Cabinet C. Reference layout diagram Figure C-2. As you open the Tray Packs place the lids into one of these boxes. Also, as the Tray Packs are used up on the serving counter, place the empty cans into the second box. The emptied cans stack well into one another and take up very little room.

- Take the remaining empty boxes that you have just opened and return them to the top levels of the Tray-Pack storage rack. This is where they will stay (empty) until the resupply truck takes them back to the MOB.

- Follow the guide (reference Figure C-3) for loading the Tray Packs into the baskets and then loading the baskets into the heater. NOTE: The only dessert items that would be heated are the COMPOTES; in all other instances set the dessert items aside -- out of the way -- until needed.

- Clamp the cover in place on the Tray-Pack heater and heat the Tray Packs for 45-60 minutes or until the boiler starts to cycle on and off.

3. PREPARING TO SERVE

STOP

IF YOU HAVE ANY CUTS, SKIN INFECTIONS, A COLD, THE FLU, OR ANY OTHER MEDICAL PROBLEMS, SEE THE MEDIC BEFORE YOU START. HE/SHE WILL ADVISE YOU IF IT IS SAFE FOR YOU TO HANDLE FOOD.

- Wear a hat; no special food handlers' hats have been provided.

- Wash hands thoroughly with the antiseptic skin cleaner in Cabinet B. Allow the lather to remain on your hands for 2 to 3 minutes before rinsing.

- In Cabinet A, take out a stack of mess trays, one box each of knives, forks, and spoons, and four packages of paper cups. Use up loose items or opened packages first. Place these items on top of Cabinet A for each customer to pick up. Also, take out a number of packets of coffee, cocoa, sugar, salt, pepper, and coffee creamer. Place these items in the compartments on the top of Cabinet A.

- Place a number of trash bags outside the vehicle for customers to dispose of used mess trays, cups, etc.

4. FEEDING

- Using the hooks provided, lift a basket of entree items out of the hot water. Remove two Tray Packs and return the basket into the water. Lift out a basket of starch items (rice, potatoes, macaroni, baked beans), remove one Tray Pack, and return the basket into the hot water, repeat for vegetables. Leave the boiler on, it automatically cycles on and off to maintain the correct serving temperature in the unused Tray Packs.

- Before opening, wipe the top of the Tray Pack dry with a clean, disposable cloth. Open the Tray Packs slowly. With one hand, guide the

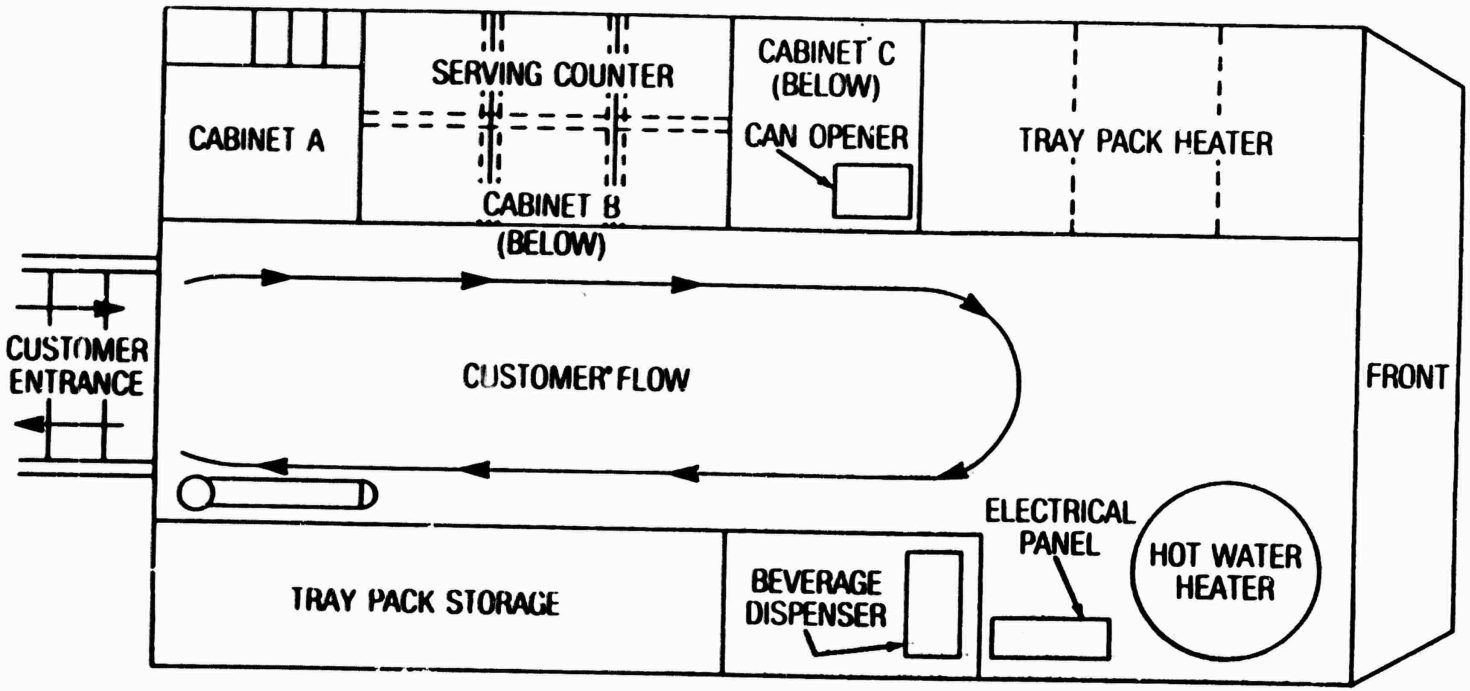

Figure C-2. Food service layout.

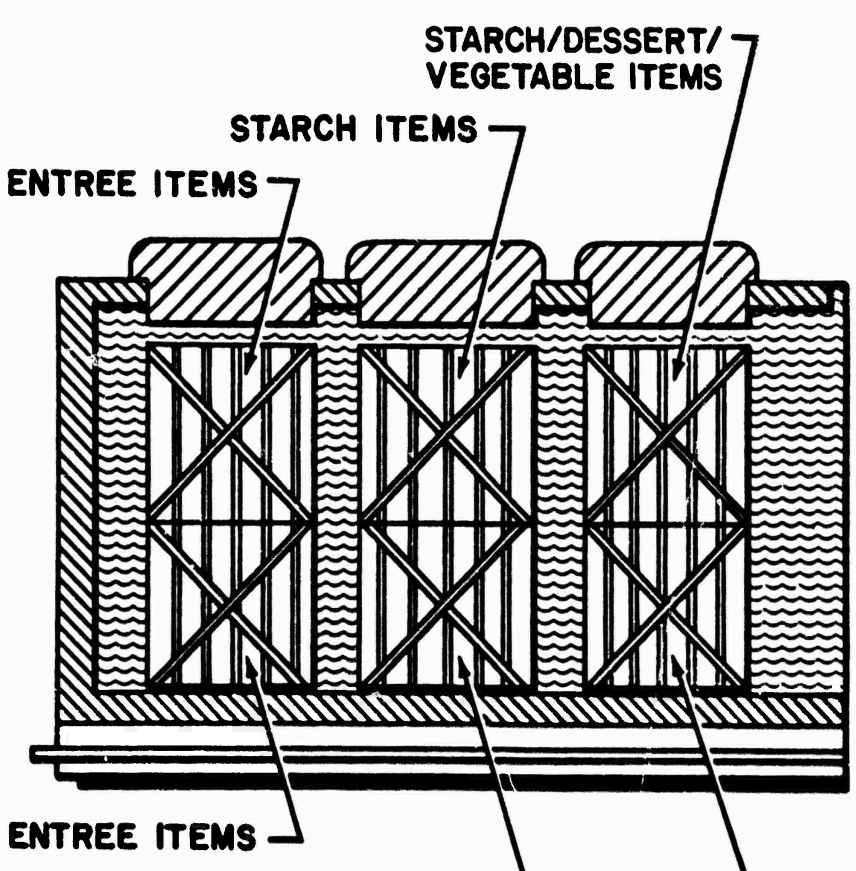

Figure C-3. Tray-Pack heater loading guide.

Tray Pack through the can opener. Place the lids in the empty box under the counter. Most of the vegetables and a few of the entree items contain a lot of liquid. Therefore, to avoid a mess, the easiest thing to do is to take the can opener and poke a hole in opposite corners of the can. Drain a small amount of the liquid out into an empty can and then con-tinue opening the can in the usual manner.

- Light the three cans of "Sterno" (TM) in the serving counter well. Arrange the opened Tray Packs on top as shown in Figure C-4.

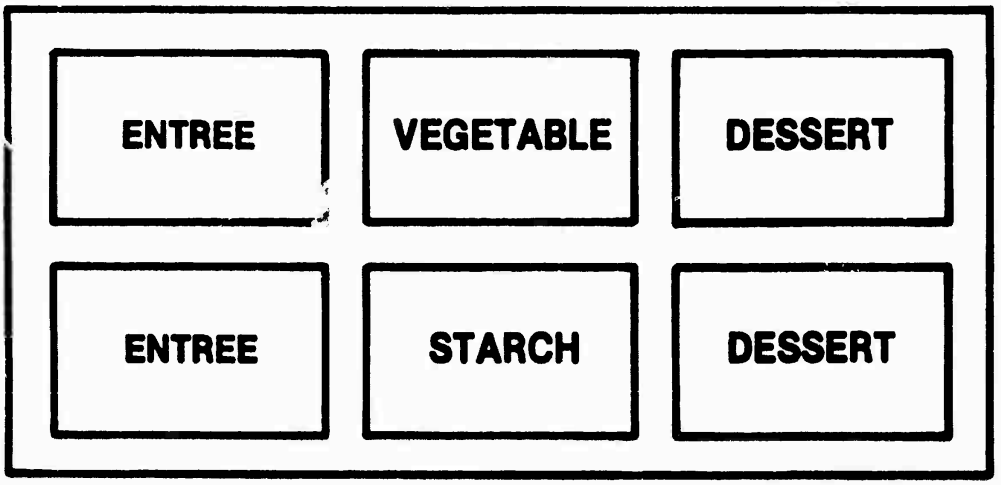

Figure C-4. Tray-Pack serving line arrangement.

- Take four plastic serving spoons from Cabinet B. Put a serving spoon in each of the different food items. These spoons will be used throughout the entire meal and will then be thrown out in the trash.

- This is a self-service system. Customers come in, take a mess tray, serve themselves, and leave. Do not allow more than two customers in the truck at once. Do not allow people to stand and wait on the stairs.

- Do not allow customers to prepare their hot beverage in the truck. This will slow down the serving line. Customers should take their hot water and beverage packets and mix them after they leave the truck.

- In the case of the entree and dessert items, as more food is needed and you open new Tray Packs, slide the partially used cans to the front of the serving counter and put the full, newly opened Tray Packs to the back. (NOTE: There is a general reluctance on the part of customers to take the last piece of meat or the last scoop of potatoes in a serving container. You will have to watch for this and possibly remove the last portions yourself and put them on top of a newly opened can.)

- Remove empty Tray-Pack cans from the serving counter and stack them under Cabinet C.

- If there is no waiting line, or the line is very short, only open one can of entree at a time. This will help to ensure that everyone gets a hot meal. Be sure that customers close the covers on the serving counter to keep the remaining food hot.

- Keep the serving counter and the can opener area clean. Wipe them off frequently with a disposable cloth using clean, hot, soapy water (all cleaning items are stored in Cabinet B).

- The assorted Tray-Pack cakes have to be cut before placing them on the serving counter. Using a plastic knife, cut each cake into fifteen pieces as shown in Figure C-5.

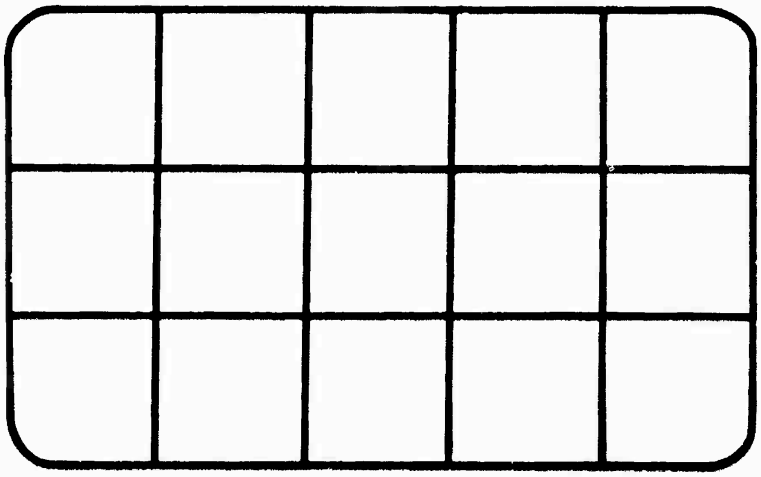

Figure C-5. Portioned Tray-Pack cake.

5. CLEANUP PROCEDURES

- At the end of the meal period, any opened cans of food must be thrown out. Unopened cans in the Tray-Pack heater should be wiped dry and returned to the closet storage area.

- Remove the empty Tray-Pack cans that have been stacked under Cabinet C, including the Tray-Pack lids, and place the items in trash bags. Try to keep the empty cans stacked together so that they don't take up more space than necessary.

- Return unused beverage packets, mess trays, cups, etc., to Cabinet A.

- Using the plastic bucket provided, draw some hot water out of the beverage heater. Add some of the liquid soap to the water, and use this solution for cleaning. Wipe down all of the counters and take particular care to clean Cabinet C thoroughly.

- Remove the can opener and wash it off thoroughly in the hot, soapy water.

- Take a new disposable cloth whenever you need one -- a sufficient supply is available in Cabinet B.

- Discard the hot, soapy water away from the truck area.

- Remove all trash to a designated location, including the trash bags outside of the vehicle containing the dirty cups and mess trays.

- Shut off the boiler, pump, and the generator.

6. INSPECTION

- Have the Medic inspect the food service area for overall sanitation.

APPENDIX D

GROUND-LAUNCHED CRUISE MISSILE FIELD FOOD SERVICE SYSTEM

FLIGHT COMMANDER GUIDELINES

Prepared for Flight Personnel
by the
Directorate for Systems Analysis and Concept Development
US Army Natick Research and Development Center

Revised
1 November 1982

- The GLCM food service system has been designed to be operated by non-food service personnel and to offer simple, quick, and quality hot meals in the field. It was never intended that this system provide soups, salads, pastries, etc.

- All flight personnel should be trained in the correct operation of the food service system prior to going into the field.

- The system is designed to serve one hot Tray-Pack meal and two operational rations (Meal, Ready-to-Eat) daily. No breakfast meal per se has been designed into this system.

- It is suggested that the hot meals be offered in the daylight hours.

- It is expected that work shifts will be modified to allow the entire flight to eat within the scheduled meal period.

- Control must be exercised over food items, particularly the operational rations. Storage requirements call for issuing two MREs per/man per/day. Do not allow these rations to be pilfered. MREs will not be stored on the food service vehicle. It was intended that these rations be stored on some other designated vehicle.

- The system is designed to be operated by a maximum of two airmen.

- The following is a guideline for meal preparation and service:

Start-up	15 minutes
Heating Time	45 minutes
Meal Service	60 minutes (variable)
Cleanup	15 minutes

- It is advisable to maintain one full day's rations (on other than the food service vehicle) in the event of a resupply delay.

- This system offers no refrigeration capability. Do not allow other than authorized food items to be stored and served.

- A working party will be needed during resupply periods to transfer food and paper goods from the resupply vehicle to the food service and other vehicles. All unused Tray Packs must be returned to the MOB. Trash should then be loaded onto the resupply vehicle to be returned also. It is not advisable to schedule meal periods during resupply exercises.

- If for any reason all or most of the water is lost in the Tray-Pack heater, careful consideration will have to be given to refilling the unit. It is doubtful that sufficient water will be available for this purpose.

- The food service vehicle is designed to tow a water trailer to support the flight's drinking water requirements.

- The entire food service system can be transferred in two parts by a crane to a similar truck in the event of vehicle failure in the field.

- A chemical/biological agent protective top has been designed for the system. The top will minimize gross liquid contamination.

- A 16' x 16' frame tent, four collapsible tables, and eight collapsible benches have been provided to serve as a dining area. The tent will require two men approximately 20 minutes to set up. These items were specifically selected for their quick setup and breakdown times. <u>These items are not an authorized part of the food service system and, if desired, will have to be carried in another vehicle</u>.

APPENDIX E

GROUND-LAUNCHED CRUISE MISSILE FIELD FOOD SERVICE SYSTEM

MEDICAL GUIDELINES

Prepared for Flight Personnel
by the
Directorate for Systems Analysis and Concept Development
US Army Natick Research and Development Center

Revised
1 November 1982

MEDIC

- Inspect food handlers.
- Inspect the food service area and equipment for cleanliness prior to the start-up of each meal.
- Be on site each meal to inspect for any bulging or leaking cans of food before they are loaded into the Tray-Pack heater.
- Monitor handling procedures and the elapsed time that Tray Packs remain open on the serving counter. Ensure that open food items do not exceed safe time/temperature standards.
- After the meal has been served, ensure that all opened cans of food are disposed of.
- Monitor trash and garbage disposal.
- Inspect the area and equipment after each meal for overall cleanliness and dismiss the food handlers.
- Provide vector control.

APPENDIX F

GROUND-LAUNCHED CRUISE MISSILE
FIELD FOOD SERVICE SYSTEM

LOGISTICS SUPPORT GUIDELINES

Prepared for Flight Personnel
by the
Directorate for Systems Analysis and Concept Development
US Army Natick Research and Development Center

Revised
1 November 1982

DISCUSSION

An intermediate storage area located between the bulk issuing facility (MOB) and the fielded flight is recommended. This area would ideally be integrated within the GLCM Support Area and be staffed with supply personnel.

The necessity for such an area arises from the need to resupply flights in the field in a simple and precise manner. The situation is twofold. One, storage space in the fielded flight is restricted; resupplying full cases (four cans) of product when only one can is required for the menu would needlessly (and dramatically) increase storage requirements. Secondly, supplies delivered to the flight must be in ready-to-use condition and not present any unnecessary work or problems for flight personnel in the field.

To facilitate a simple and smooth resupply in the field, a certain amount of preparatory work is required in configuring the load before it goes out into the field. The Support Area is far better suited to handle this work than are flight personnel in the field.

Exact inventory levels of supplies to be maintained at the bulk issuing facility and the GLCM Support Area are impossible to estimate at this time based on the numerous uncertainties surrounding Support Area resources and the frequency and duration of field exercises.

It is recommended that one supply person at the Support Area be assigned the specific responsibility of providing food service support to flights in the field. Depending on the frequency of field training exercises, this could represent a full-time position.

Job responsibilities would include the following:

1. Maintain adequate inventory levels of food, disposables, and supplies;

2. Maintain appropriate financial accountabililty records;

3. Maintain a file (record) of scheduled field training exercises with the resupply dates and times;

4. Prepare shipments of food, disposables, and supplies to resupply flights in the field.

The resupply storage and assembly area should have sufficient shelving to inventory broken case lots of Tray Packs and disposables, etc. Two to four work tables (36" x 72") should be provided for opening, repackaging, labeling, and assembling resupply orders.

When a flight is scheduled for a field exercise, the responsible supply person should be provided with the following information:

- Length of exercise (days);
- Number of flight personnel;
- Initial load out day/time;
- Scheduled resupply dates/times.

The airman will then get a copy of the standard 30-day GLCM Menu. The menu has been designed to support 70 men. If the actual number of men on a training exercise varies, then the GLCM Tray-Pack Portion List (Table F-1) should be referenced to make necessary adjustments for more or less people, remembering to always round up to the nearest full can.

NOTE: Using one heating cycle, the maximum number of people that the system can support is approximately 100. The 30-day menu that is provided is not a static document. As a greater variety of Tray Packs become available in the supply system the menu should be updated to reflect these changes. If certain items are identified as unpopular or unacceptable, then they should be removed from the menu. As more historical data becomes available on portion sizes in this unique self-service system, quantities of products to be resupplied should be adjusted accordingly.

When configuring a resupply loadout, remove the appropriate number of cases or product from inventory on a per meal basis. Check the shelves first for any single cans of product. The shelves should be set up in such a manner that items are stacked by category (entrees, vegetables, desserts, etc.) and within each category in alphabetical order (for example, carrots, corn, peas, etc). This will simplify the task of locating single cans of product. If the system is used correctly, then no more than six individual cans of a specific item would ever be on the shelf at a given time.

Figure F-1 represents how a hypothetical meal (DAY 1 - MEAL 1) would be assembled for resupply. Proposed quantities of Tray Packs are for illustrative purposes only.

Assuming no open cans of product were on the shelf, four cases of beef stew, two cases of potatoes, two cases of lima beans, and two cases of blueberry compote would be taken out of inventory. Three cases of beef stew and one case each of potatoes, lima beans, and blueberry compote would be set aside on a cleared table. The remaining case of beef stew, potatoes, lima beans, and blueberry compote would be taken to the reassembly table and the cases carefully opened.

To complete the meal order, three cans of beef stew, two cans of potatoes, one can of lima beans, and two cans of blueberry compote must be repackaged into two of the opened cases. The remaining can of product would then be stored on the shelves.

TABLE F-1. GLCM Tray-Pack Portion List.

Entrees	Estimated Servings Per Can
Barbequed Beef	7
Beef Stew	7
Beef Stroganoff	7
Beef Tips	12
Chicken a la King	10
Chicken Breasts	6
Chicken Cacciatore	6
Chicken & Noodles	7
Chili	7
Lasagna	7
Macaroni Beef	7
Ravioli	7
Roast Beef	14
Roast Pork	12
Salisbury Steak	7
Stuffed Cabbage	7
Stuffed Peppers	7
Starches	
Baked Beans	19
German Potato Salad	19
Macaroni & Cheese	19
Potatoes in Brine	19
Scalloped Potatoes	19
Spanish Rice	19
Vegetables	
Carrots	19
Corn	19
Green Beans	19
Lima Beans	23
Peas	19
Stewed Tomatoes	19
Desserts	
Apple Compote	18
Blueberry Compote	18
Cherry Compote	18
Coffee Cake	18
Peach Compote	18
Peaches	18
Pound Cake	18

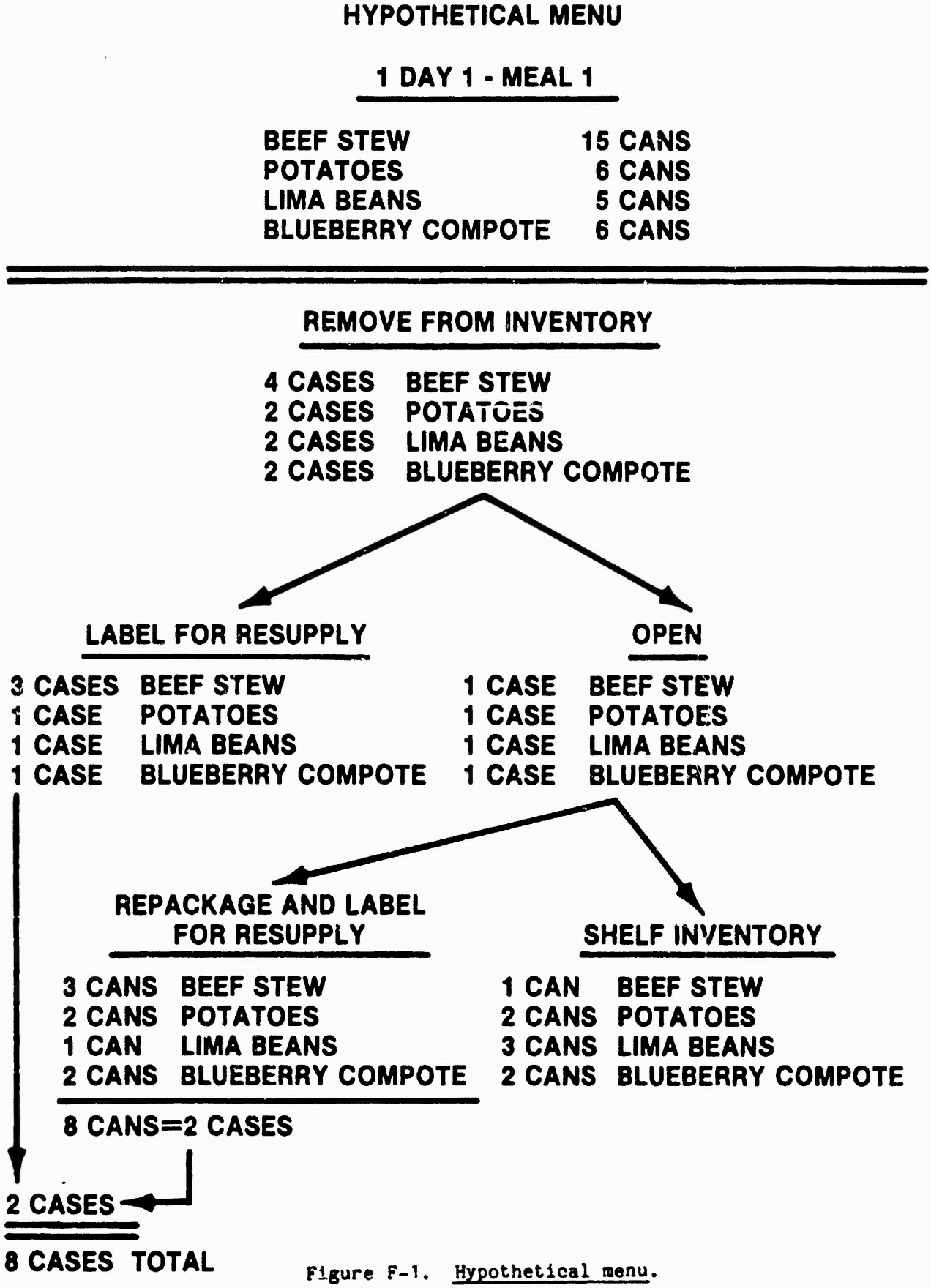

Figure F-1. Hypothetical menu.

The two cases of assorted items should be carefully resealed with reinforced tape. All eight cases that make up the meal should then be clearly marked (on end) DAY 1- MEAL 1 using the labels provided (see Fig. F-2). This eliminates any guesswork on the part of the food service attendant in the field.

Once each meal has been assembled, a second person should check the order for accuracy. In addition, once the entire resupply order has been assembled, a second person should check the order for accuracy.

Using the Recapitulation Worksheet (Fig. F-3) fill out the quantities of each item being resupplied to the flight for that specific time period.

When the resupply convoy reaches the flight in the field, all the Tray-Pack cases on the food service vehicle (partially full or empty) are to be off-loaded. The pallet of new supplies should then be loaded from the resupply vehicle into the food service vehicle, and the new cases stacked properly into the Tray-Pack storage area. All the partially full and empty cases that were on the food service vehicle will then be transported back to the MOB.

When the resupply convoy returns to base, any returned Tray Packs will be inventoried and posted to the Recapitulation Worksheet. The worksheet will then provide a record of food consumed by a specific number of people during a specific period of time.

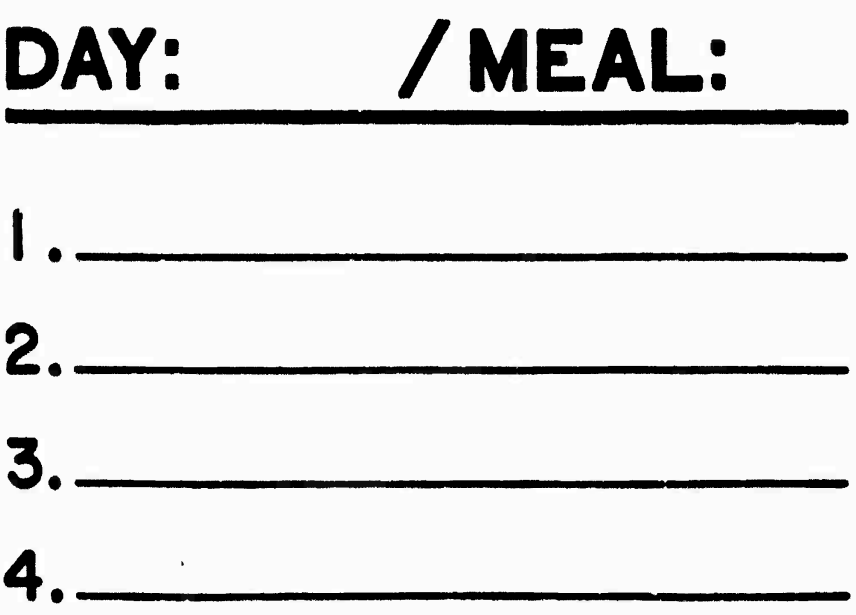

Figure F-2. Case label.

FLIGHT DESIGNATION: SUPPORT PERIOD: _____to _____, FL. COMPLEMENT_____

Item	Quantity Shipped	Quantity Returned	Quantity Expended	Unit Cost	Total Cost
Entrees:					
Barbequed Beef					
Beef Stew					
Beef Stroganoff					
Beef Tips					
Chicken a la King					
Chicken Breasts					
Chicken Cacciatore					
Chicken & Noodles					
Chili					
Lasagna					
Macaroni Beef					
Ravioli					
Roast Beef					
Roast Pork					
Salisbury Steak					
Stuffed Cabbage					
Stuffed Peppers					
Starches:					
Baked Beans					
German Potato Salad					
Macaroni & Cheese					
Potatoes in Brine					
Scalloped Potatoes					
Spanish Rice					
Vegetables:					
Carrots					
Corn					
Green Beans					
Lima Beans					
Peas					
Stewed Tomatoes					
Desserts:					
Apple Compote					
Blueberry Compote					
Cherry Compote					
Coffee Cake					
Peach Compote					
Peaches					
Pound Cake					

Figure F-3. GLCM subsistence inventory recapitulation worksheet.

APPENDIX G

PROPYLENE GLYCOL

DOWFROST*

INTRODUCTION

Although water is the most widely used heat transfer fluid, it cannot be used alone in applications involving temperatures below 0°C (32°F). Where such temperatures are encountered, aqueous solutions of Dowfrost specially inhibited propylene glycol have proven highly effective as heat transfer media.

Besides providing low temperature freeze protection, solutions of Dowfrost possess other desirable properties. These include high boiling points, stability over a wide temperature range, little or no fire hazard, low coefficients of thermal expansion, high specific heats and thermal conductivities, extremely low toxicity, and noncorrosivity.

Because of their low toxicity, solutions of Dowfrost are widely used by the food industry for the cooling of foods and beverages, the immersion freezing of wrapped fish and poultry, and freezer coil defrosting. Outside the food industry, solutions are used by municipal fire departments as fire hydrant freeze point depressants.

A bulletin discussing the physical properties, uses, handling and storage, toxicity, reconcentration and analysis of Dowfrost inhibited propylene glycol and its solutions, and providing detailed engineering data along with further information and samples are available upon request from The Dow Chemical Company, Specialty Chemical Department, 2020 Dow Center, Midland, Michigan 48674.

*Trademark of the Dow Chemical Company.

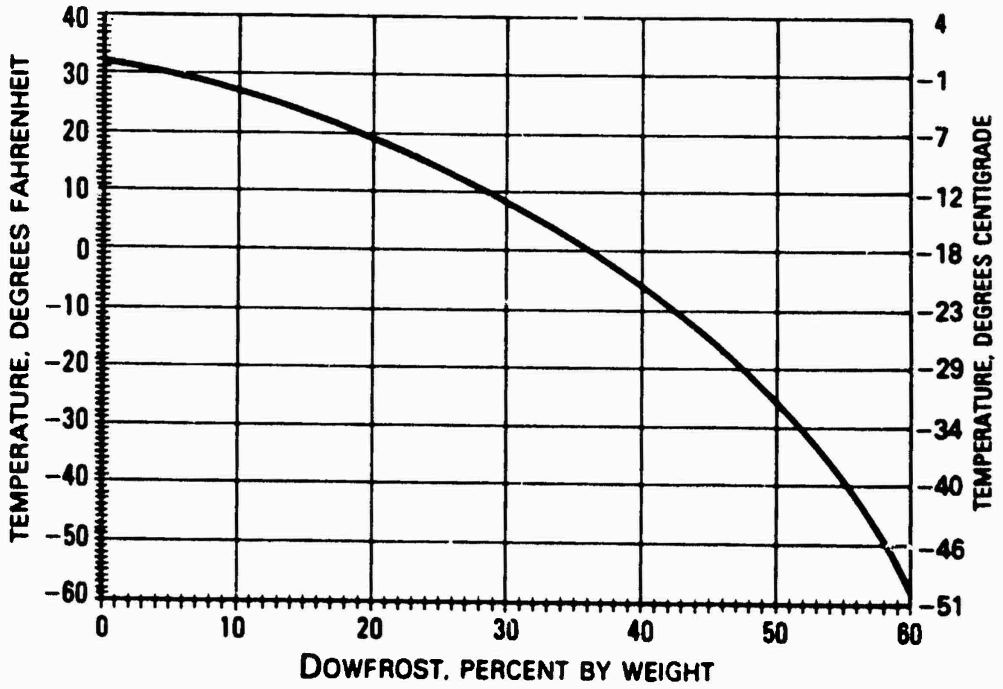

Figure G-1. Freezing point of aqueous solutions of Dowfrost* (TM).

*Dowfrost, The Dow Chemical Company, Form #173-560-80, 1475.

APPENDIX H

FOOD SERVICE EQUIPMENT AND PERFORMANCE DATA

PRIME MOVER

Vehicle

Description: A 5-ton cargo vehicle (long bed) was used for the prototype due to the nonavailability of an M-925. The M-925 will, however, be the vehicle used in Europe by GLCM flights once deployed.

Performance: Only that portion of the bed that conforms to the M-925 was utilized in the design of the field food service system. No modifictions will therefore be necessary when the system is eventually transferred onto the M-925. The overall height of the vehicle, including bow extenders and covers, was in accordance with STANAG 2154, which specifies a height not to exceed 13.12 feet.

Vehicle Covering

Description: A standard canvas cover for the vehicle was modified as follows:

(1) canvas sides were lengthened to accommodate bow extensions;

(2) two 35" x 70" screened window openings with flaps were added for better ventilation;

(3) a screened rear panel was fabricated for the entrance;

(4) a stove pipe opening was cut in the roof.

Performance: The modification of the standard vehicle covering was successful and future systems will include these modifications.

Chemical/Biological Protective Overcover

Description: The overcover was manufactured from cloth; laminated coated with Chloroprene, forest green (MIL-C-43944 Type I, Class I). The cover was butt-seam constructed with a heavy duty zip-lock closure on the entrance. The cover was designed to slip over the existing canvas cover and be secured underneath the vehicle.

Performance: The overcover was not tested during the "model mission". It has, nonetheless, remained as part of the overall system and was included in the Specification of Purchase.

Pallets

Description: All equipment was attached to two equal sized steel pallets each measuring 6'6" long and 6'11" wide. These pallets were secured to the bed of the vehicle with four side-locking bolts. The slats of the pallets were 4" wide and spaced 1" apart. The design allows for easy removal of the system by forklift or crane in case of vehicle breakdown.

Performance: The pallets as designed made cleaning difficult. Occasionally food would drop between the slats and could only be cleaned out with a hose. A modification to future systems will be made to correct this condition while still allowing for the pallets to be removed by forklift or crane. The pallet securing mechanism and the attachment of the system components to the pallets, having proved successful, will remain the same.

Stairway

Description: The stairway with railings leading to the vehicle consisted of seven steel steps. The stair treads were of the all-weather open-diamond shape with serrated surfaces. It attached to the back of the vehicle with two hooks and was secured inside the vehicle during transit. The stair treads were 36" wide, 9" deep with a rise of 8". Stair railings are detachable.

Performance: The stairway proved successful. Future units will, however, be made of aluminum to reduce the overall weight.

MEAL PREPARATION/SERVING EQUIPMENT

Tray-Pack Heater

Description: The Tray-Pack heater (a stainless steel tank) was designed to heat six baskets simultaneously with each basket holding five Tray Packs. Hot water was used as the heat source to bring the Tray Packs to a temperature of 180°F. One inch polyurethane foam insulation was installed at Dugway to reduce heat loss. A three-section hinged lid covered the heater. Each section of the lid can be secured with latches on the sides of the tank to reduce spillage when the truck is moving. A 1/2-HP pump is mounted under the tank and circulates a 50/50 mixture of water and propylene glycol from the water heater and through the tank. The propylene glycol was used to prevent freezing during cold weather.

Performance: The unit successfully heated and maintained the Tray Packs at the serving temperature of 180°F. Heating times varied depending on ambient temperatures. The addition of the insulation helped reduce this time. No malfunctions occurred during the entire test. Minor modifications will be made in future units to reach and maintain the desired temperature within 40 minutes.

Serving Counter

Description: The serving line consisted of three Cambro insulated containers, Model 125 MPC, each measuring 25" x 17" x 5¼", which were inserted into the top of a stainless steel shell. Each container held two Tray Packs and had an insulated top to keep the Tray Packs hot (140°F) during serving periods.

Performance: The serving line, as designed, proved inadequate and could not keep the contents of the Tray Packs sufficiently warm under below freezing ambient temperatures. The insulated containers were removed and the Tray Packs were inserted directly into a modified stainless steel shell. Canned fuel was then used under the Tray Packs until a more permanent solution could be implemented.

Beverage Dispenser (in-house model)

Description: A hot beverage dispenser was mounted to the top of a storage cabinet across from the Tray-Pack heater. It was constructed from stainless steel, with a Chromalox Immersion Heater (15 amps, 240 volts, 1500 watts), which heated the water for hot beverages.

Performance: The in-house (replacement) hot water dispenser (see Section VI) operated successfully. The recovery rate was adequate as evidenced by the fact that the unit had no difficulty keeping up with line demand.

Can Opener/Counter

Description: The can opener used was an Edland Model 1-R. The customary base plate was not required and the opener was mounted directly to the top of the stainless steel cabinet. The bayonet-type blade on the can opener was the best design to open Tray Packs. The opener is constructed of cast iron with hardened and tempered steel knife and gear.

Performance: The can opener operated successfully throughout the test.

UTILITIES

Water Heater

Description: The water heater used was a commercial Way-Wolff Ship Heater model 917-6C. It was of the fire tube, two-pass design. A combustion chamber comprised the first pass and the return fire tubes the second pass. The boiler was welded steel construction throughout. The oil burner was a fully automatic, high-pressure atomizing type, with a motor directly connected to a blower supplying air for combustion. A fuel unit draws oil from the fuel tank and delivers it under controlled pressure to the atomizing nozzle. The heater delivered a maximum of 80,000 Btu/hr under heavy load conditions and 50,000 Btu/hr under normal conditions. The unit used diesel fuel oil per

Specification MIL-F-16884. The electrical requirements were Direct Current 32 or 15 volts, or Alternating Current 110 or 220 volts, 50 or 60 cycles, single phase. Wattage requirements were starting 325, running 150. It had a maximum firing rate of .75 gal/hr.

Performance: The water heater performed flawlessly with no breakdowns throughout the entire exercise.

Generator

Description: The generator used was a commercial type Onan DJA Series. It was a 3-kW diesel fuel engine with a 30-cubic-inch piston displacement, 19 to 1 compression ration, and was air cooled. The diesel fuel consumption is 0.21 gal/hr under no load, 0.26 gal/hr under half load, and .34 gal/hr under full load. There are currently no 3-kW diesel fueled generators in the military system. One is now under development and can be substituted with minor modifications when adopted for military applications.

Performance: The generator supplied adequate power for the entire food service system. No breakdowns were observed. It will continue to be used until a military unit is fully developed and adopted.

Lighting Fixtures

Description: The lighting fixtures were a standard stock item NSN 6210-00-548-0222. There were four overhead fixtures (two on each side) attached to the bows supporting the canvas cover on the truck. Each fixture had two white fluorescent tubes for normal use and either a blue/green or red tube for black-out conditions. Each tube draws 20 watts.

Performance: No malfunction of the lighting fixtures were recorded and they will be used in future systems.

OTHER

Storage cabinets

Description: The storage cabinets for the Tray Packs, disposable serviceware,, and cleaning materials were constructed from 3/4" plywood and provided approximately 55 cubic feet of storage space. The Tray Packs were stored in the racks and cabinet on the right side of the vehicle while the disposable serviceware and miscellaneous materials were stored in cabinets on the left.

Performance: The storage space provided was adequate for the resupply cycle, and no problems were encountered during the exercise. Wooden cabinets were provided as an expedient measure. Future cabinets will be constructed from stainless steel.

Optional Dining Equipment

(1) Tent

Description: A 16' x 16' frame-type tent, providing space for four tables and eight benches, was made available to the Air Force for the exercise.

Performance: The unit was not used.

(2) Tables and benches

Description: Four tables and eight benches were provided for dining purposes. Both are commercial items by Correll, Inc. The tables are the folding leg type with honeycomb core and high pressure plastic surface. They measure 72" x 30" x 36". The folding benches have a plastic seat surface and measure 72" x 15" x 17".

Performance: The tables and benches used were adequate for the number of personnel served. They did however, deteriorate, having been exposed to continuously rainy conditions over the 30-day Ft. Lewis test.

APPENDIX I

GLCM FOOD SERVICE
INTERVIEWS AND SURVEYS

GLCM Customer Interview

1. Are there any food items you'd like to see added to the GLCM food system?

   (Probes: bread, fruit, salad, beverages)

2. Are there any food items you'd like deleted?

3. Are there any other changes you'd recommend for the food system?

4. Did you have any problems getting to the kitchen to eat?

5. Should coffee/hot chocolate be available other than at the hot meal?

6. Did you have any problems with the MRE?

7. How often did you heat your MRE? (If did not, Why?)

8. Did you get enough water?

   a. to drink?
   b. to reconstitute parts of the MRE?

9. Should there be a tent to eat in for the GLCM system? Why (not)?

GLCM Officer Interview

1. Should at least one hot meal a day be provided to GLCM personnel? Why (not)?

2. What is your ove reaction to the present GLCM food system?

3. Did any of your people have problems getting to the kitchen to eat the hot meal?

4. Does the GLCM kitchen compromise the security of your mission in any way?

GLCM Food Service Attendant Interview

1. What do you like about the GLCM kitchen?
2. What do you dislike about the GLCM kitchen?
3. Is there any piece of equipment that you had problems with?
4. Was there any problem getting the Tray Packs from the supply trucks?
5. Would you suggest relocating anything on the GLCM truck?
6. Should there be a tent to eat in for the GLCM system? Why (not)?
7. Are there any other changes you would recommend for the GLCM food system?

APPENDIX I

GLOM FOOD ACCEPTANCE

WE NEED YOUR EVALUATION OF EACH FOOD ITEM IN THIS MEAL TO SEE HOW ACCEPTABLE THE FOODS ARE AND IF THE TEMPERATURE OF EACH ITEM IS CORRECT. PLEASE RATE ACCEPTABILITY OF THE MEAL OVERALL, ACCEPTABILITY OF EACH FOOD ITEM, AND THEN THE TEMPERATURE OF EACH FOOD ITEM.

1. WHAT IS YOUR JOB? _____

2. PLEASE RATE THE ACCEPTABILITY OF THIS MEAL OVERALL BY CIRCLING THE NUMBER THAT BEST EXPRESSES YOUR OPINION.

9 EXTREMELY GOOD
8 VERY GOOD
7 MODERATELY GOOD
6 SLIGHTLY GOOD
5 NEUTRAL
4 SLIGHTLY BAD
3 MODERATELY BAD
2 VERY BAD
1 EXTREMELY BAD

3. USING THE SAME SCALE, PLEASE RATE THE ACCEPTABILITY OF EACH FOOD ITEM IN YOUR MEAL BY CIRCLING THE APPROPRIATE NUMBER.

9 EXTREMELY GOOD	9 EXTREMELY GOOD	9 EXTREMELY GOOD	9 EXTREMELY GOOD
8 VERY GOOD	8 VERY GOOD	8 VERY GOOD	8 VERY GOOD
7 MODERATELY GOOD	7 MODERATELY GOOD	7 MODERATELY GOOD	7 MODERATELY GOOD
6 SLIGHTLY GOOD	6 SLIGHTLY GOOD	6 SLIGHTLY GOOD	6 SLIGHTLY GOOD
5 NEUTRAL	5 NEUTRAL	5 NEUTRAL	5 NEUTRAL
4 SLIGHTLY BAD	4 SLIGHTLY BAD	4 SLIGHTLY BAD	4 SLIGHTLY BAD
3 MODERATELY BAD	3 MODERATELY BAD	3 MODERATELY BAD	3 MODERATELY BAD
2 VERY BAD	2 VERY BAD	2 VERY BAD	2 VERY BAD
1 EXTREMELY BAD	1 EXTREMELY BAD	1 EXTREMELY BAD	1 EXTREMELY BAD

4. NOW PLEASE RATE THE TEMPERATURE OF EACH FOOD ITEM BY AGAIN CIRCLING THE APPROPRIATE NUMBER FOR EACH.

7 MUCH TOO HOT	7 MUCH TOO HOT	7 MUCH TOO HOT	7 MUCH TOO HOT
6 SOMEWHAT TOO HOT	6 SOMEWHAT TOO HOT	6 SOMEWHAT TOO HOT	6 SOMEWHAT TOO HOT
5 SLIGHTLY TOO HOT	5 SLIGHTLY TOO HOT	5 SLIGHTLY TOO HOT	5 SLIGHTLY TOO HOT
4 JUST RIGHT	4 JUST RIGHT	4 JUST RIGHT	4 JUST RIGHT
3 SLIGHTLY TOO COLD	3 SLIGHTLY TOO COLD	3 SLIGHTLY TOO COLD	3 SLIGHTLY TOO COLD
2 SOMEWHAT TOO COLD	2 SOMEWHAT TOO COLD	2 SOMEWHAT TOO COLD	2 SOMEWHAT TOO COLD
1 MUCH TOO COLD	1 MUCH TOO COLD	1 MUCH TOO COLD	1 MUCH TOO COLD

5. WHAT TYPE OF MEAL WAS THE MEAL YOU ATE JUST BEFORE THIS ONE? (CIRCLE ONE)

MRE LRP T RATION OTHER _____

6. PLEASE RATE THE OVERALL ACCEPTABILITY OF THAT MEAL YOU ATE JUST BEFORE THIS ONE.

9 EXTREMELY GOOD
8 VERY GOOD
7 MODERATELY GOOD
6 SLIGHTLY GOOD
5 NEUTRAL
4 SLIGHTLY BAD
3 MODERATELY BAD
2 VERY BAD
1 EXTREMELY BAD

GLCM FOOD SERVICE ATTENDANT SURVEY

1. What is your main GLCM job?_____

2. What is your OVERALL impression of the GLCM food service system? (Please check one)

_____1. VERY BAD
_____2. MODERATELY BAD
_____3. SOMEWHAT BAD
_____4. NEITHER BAD NOR GOOD
_____5. SOMEWHAT GOOD
_____6. MODERATELY GOOD
_____7. VERY GOOD

PLEASE USE THE FOLLOWING SCALE FOR THE NEXT QUESTION.

VERY BAD	MODERATELY BAD	SOMEWHAT BAD	NEITHER BAD NOR GOOD	SOMEWHAT GOOD	MODERATELY GOOD	VERY GOOD
1	2	2	4	5	6	7

3. PLEASE rate each factor below on HOW GOOD OR BAD you feel it is in the GLCM food service system.

a.	Type and amount of equipment to do the job	1	2	3	4	5	6	7
b.	Sanitary conditions in the kitchen	1	2	3	4	5	6	7
c.	Amount of storage space	1	2	3	4	5	6	7
d.	How easy to get at supplies	1	2	3	4	5	6	7
e.	Amount of working space	1	2	3	4	5	6	7
f.	Noise	1	2	3	4	5	6	7
g.	Lighting in the kitchen	1	2	3	4	5	6	7
h.	Bumping into other people while working	1	2	3	4	5	6	7
i.	Temperature in the kitchen	1	2	3	4	5	6	7
j.	The height of the roof in the kitchen	1	2	3	4	5	6	7
k.	The kitchen OVERALL	1	2	3	4	5	6	7

4. How do you feel about being a food service attendant in addition to doing your main job? (Please check one)

_____ 1. Strongly prefer just doing my main job.
_____ 2. Moderately prefer just doing my main job.
_____ 3. Somewhat prefer just doing my main job.
_____ 4. I don't really care one way or the other.
_____ 5. Somewhat prefer being an attendant in addition to my main job.
_____ 6. Moderately prefer being an attendant in addition to my main job.
_____ 7. Strongly prefer being an attendant in addition to my main job.

PLEASE TURN THE PAGE

5. Do you prefer the present GLCM food service system where it is operated by people like yourself having food service attendant as an additional duty, or should a cook or cooks be assigned? (Please check one)

_____ 1. Strongly prefer present system.
_____ 2. Moderately prefer present system.
_____ 3. Somewhat prefer present system.
_____ 4. Neutral
_____ 5. Somewhat prefer cook(s) be assigned.
_____ 6. Moderately prefer cook(s) be assigned.
_____ 7. Strongly prefer cook(s) be assigned.

PLEASE USE THE FOLLOWING SCALE FOR NEXT QUESTION.

VERY HARD	MODERATELY HARD	SOMEWHAT HARD	NEITHER HARD NOR EASY	SOMEWHAT EASY	MODERATELY EASY	VERY EASY
1	2	3	4	5	6	7

6. Please rate each factor below on HOW HARD OR EASY you found it in the GLCM food service system.

a.	Starting the generator	1	2	3	4	5	6	7
b.	Operating the present hot beverage dispenser	1	2	3	4	5	6	7
c.	Operating the hot water heater	1	2	3	4	5	6	7
d.	Loading Tray Packs into baskets for heating	1	2	3	4	5	6	7
e.	Placing the basket into the heater	1	2	3	4	5	6	7
f.	Removing the basket from the heater	1	2	3	4	5	6	7
g.	Opening Tray-Pack cans	1	2	3	4	5	6	7
h.	Placing opened Tray Pack into serving line	1	2	3	4	5	6	7
i.	Cleaning the serving line	1	2	3	4	5	6	7
j.	Cleaning the can opener	1	2	3	4	5	6	7
k.	Cleaning the floor	1	2	3	4	5	6	7
l.	Setting up trash bags for the customer	1	2	3	4	5	6	7
m.	Offloading the generator from the truck	1	2	3	4	5	6	7
n.	Making electric and fuel connections	1	2	3	4	5	6	7
o.	Disconnecting electric and fuel connections	1	2	3	4	5	6	7
p.	Replacing the generator onto the truck	1	2	3	4	5	6	7
q.	How hard or easy for customer to serve self	1	2	3	4	5	6	7
r.	Camouflaging the kitchen	1	2	3	4	5	6	7

GLCM CUSTOMER SURVEY

Please help us evaluate the Ground-Launch Cruise Missile (GLCM) food service system by answering the following questions:

1. What is your job?_____

2. For each part of this question please circle the number that best expresses your opinion of food service on this exercise.

	VERY BAD	MODER-ATELY BAD	SOME-WHAT BAD	NEITHER BAD NOR GOOD	SOME-WHAT GOOD	MODER-ATELY GOOD	VERY GOOD
a. Your overall reaction to Tray Packs.	1	2	3	4	5	6	7
b. Your overall reaction to MREs.	1	2	3	4	5	6	7
c. Quality of Tray Packs	1	2	3	4	5	6	7
d. Quality of the MRE	1	2	3	4	5	6	7
e. Quantity in a Tray-Pack Meal.	1	2	3	4	5	6	7
f. Quantity in a MRE Meal	1	2	3	4	5	6	7
g. Variety of Tray Packs	1	2	3	4	5	6	7
h. Variety of MREs	1	2	3	4	5	6	7
i. Temperature of Tray-Pack Food	1	2	3	4	5	6	7
j. Temperature of MRE food	1	2	3	4	5	6	7
k. Ease of serving yourself from a Tray Pack	1	2	3	4	5	6	7
l. Ease of preparing the MRE	1	2	3	4	5	6	7
m. Paper cups	1	2	3	4	5	6	7
n. Trays (paper)	1	2	3	4	5	6	7
o. Plastic Utensils	1	2	3	4	5	6	7
p. Trays (styrofoam)	1	2	3	4	5	6	7

PLEASE TURN THE PAGE

3. If you had a choice, would you prefer the present GLCM food service system with 2 MREs and 1 Tray-Pack meal a day, or 3 MREs a day?

1. Strongly prefer 3 MREs.
2. Moderately prefer 3 MREs.
3. Somewhat prefer 3 MREs.
4. No preference.
5. Somewhat prefer 1 Tray Pack and 2 MREs.
6. Moderately prefer 1 Tray Pack and 2 MREs.
7. Strongly prefer 1 Tray Pack and 2 MREs.

4. If you had a choice, would you prefer the present GLCM food service system with 2 MREs and 1 Tray-Pack meal a day, or 1 MRE and 2 Tray-Pack meals a day.

1. Strongly prefer 1 MRE and 2 Tray Packs.
2. Moderately prefer 1 MRE and 2 Tray Packs.
3. Somewhat prefer 1 MRE and 2 Tray Packs.
4. No preference.
5. Somewhat prefer 2 MREs and 1 Tray Pack.
6. Moderately prefer 2 MREs and 1 Tray Pack.
7. Strongly prefer 2 MREs and 1 Tray Pack.